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BRUNSWICK SMELTING FINAL REPORT FOR SLAG FUMING FEASIBILITY STUDY

Brunswick Smelting
Belledune, New Brunswick

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Hon. Donald Arsenault
Minister of Natural Resources

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BRUNSWICK SMELTING
BELLEDUNE, NEW BRUNSWICK

FINAL REPORT

FOR

SLAG FUMING FEASIBILITY STUDY

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1. EXECUTIVE SUMMARY AND CONCLUSIONS

A feasibility study for a slag fuming facility at Brunswick Smelting's Belledune site has been performed by Hatch Associates. The facility is based on using the Enviroplas Process, developed by Mintek, to recover zinc by fuming blast furnace slag.

The feasibility study has included an evaluation of implementation options, development of a process design basis, flowsheet development and engineering required to produce a feasibility level capital cost estimate.

Hatch feasibility study concludes the following:

1. The process design basis for the slag fuming facility based on the testwork performed by Mintek is reasonable, but additional, larger scale, tests are warranted to firm up the scalability of the process.
2. The use of an all cold slag feed, rather than a molten slag feed, to the process presents much less of a technical challenge for a new process in an existing plant and is recommended.
3. The existing plant site can accommodate the new slag fuming installation with a modest degree of modification and disruption to plant operations.
4. The cost of the new facility is estimated to be $93,000,000 CDN. This has been arrived at by a feasibility grade cost estimate with appropriate contingency determined by risk analysis.
5. The key item of process equipment is a 10 m diameter DC electric arc furnace. At this stage the furnace design is conceptual and considerable development work is required before a final design can be implemented.
6. The remainder of the plant consists of proven, conventional equipment. The lead splash condenser has been proven in ISP blast furnace applications and should be adaptable for this service.

2. INTRODUCTION

The Brunswick Smelting Division of Noranda Mining and Exploration Inc. has undertaken a program to evaluate upgrading the lead smelting operation in Belledune, New Brunswick. This modification would incorporate fuming of the blast furnace slag to recover zinc. It would allow the smelter to accept a broader range of feed materials and to process the existing dump slag at the site.

This report describes the results of an engineering feasibility study for a slag fuming facility at the Belledune site performed by Hatch Associates at the request of Brunswick. The feasibility study includes evaluation of implementation options, development of a process design basis, process flowsheet, material and energy balances, plant arrangement, and other engineering required to develop a feasibility level capital cost estimate.

3. BACKGROUND

The Enviroplas process, developed by Mintek in South Africa, treats zinc-containing slag in a DC electric arc furnace by reaction with coke to produce a metallic zinc vapour. The zinc is recovered as metal in an ISP type lead splash condenser. This process is potentially applicable to the treatment of lead blast furnace slag from the Belledune Smelter.

The Enviroplas process is capable of treating slags of much higher zinc content than is presently produced at Belledune, thereby allowing the smelter to accept high zinc feed materials. The overall process economics would be enhanced by low cost feed materials and by high zinc recoveries per unit of slag processed by the Enviroplas zinc fuming furnace. Proposed feed materials include Brunswick bulk concentrates, high zinc EAF dusts and other secondary materials. In addition, much of the slag which has been generated by the blast furnace over the years and stockpiled as "dump slag", is considerably higher in zinc content than that presently produced. This dump slag can be reclaimed and treated along with the high zinc blast furnace slag to be produced with the new mix of feed materials.

The evaluation of the slag fuming process has been carried out in two parts: pilot testing and feasibility study. The pilot testing was conducted in September 1997 by Mintek in conjunction with and in accordance with a test program developed by Brunswick. The feasibility study performed by Hatch Associates under Brunswick's direction, was initiated simultaneously with the pilot plant test planning. When the preliminary results of the pilot testing became available, these were incorporated into the design basis for the feasibility study.

4. OPTIONS CONSIDERED AND DESIGN SELECTION

The blast furnace at Belledune was designed as an ISP furnace and has since been modified to operate strictly as a lead blast furnace. One option that was initially proposed by Brunswick for this study was to replace the existing blast furnace with a new higher throughput furnace specifically designed for the new operation. Due to the extended down time that would be required for construction and commissioning of the new blast furnace, and the uncertainty of the results achieved, Brunswick decided not to pursue this option.

In the original concept for slag processing, molten slag was transferred from the blast furnace to the slag fuming facility, which would consist of two furnaces: a premelting furnace and a fuming furnace. An evaluation was made to determine the best location for the facility within the existing site. Three options were considered: 1) north of the blast furnace building;
2) adjacent to the south side of the blast furnace and extending outside of the blast furnace building and 3) in the open area northwest of the blast furnace building.

Option 3 was selected as the most desirable, offering the greatest flexibility and fewest constraints on the new facility, with the least disruption and relocation of existing facilities. All of the options suffered from the need to handle and transfer molten slag in ladles and the extensive hygiene system required controlling the ladle and slag transfer fumes.

The complications involved with adapting an existing plant to handle molten slag led to consideration of all solid slag feed to the fuming facility. A study of solid vs. molten feed options (See Report, Slag Fuming Options, App.) clearly identified the advantage of all solid feed, but at a considerable penalty in energy requirements. After determining that the project economics were still favourable, Brunswick decided that the feasibility study should be continued on the basis of an all solid slag feed.

5. DESIGN BASIS

Table 5-1 presents the parameters used as the basis for the process design for this feasibility study. The following describes how these parameters were derived.

Table 5-1: Process Design Basis

Overall Process		
Operating factor (350 days per year, 85% availability, 7140 hrs/yr)		81.5%
Blast Furnace slag feed		145,000 tpa
Dump slag feed		130,000 tpa
Total slag processed		275,000 tpa
Prime Western Zinc production		26,000 tpa
Prime Western Zinc composition	Zn	98.5%
	Pb	1.2%
	Others	0.3%
Blue powder production		4800 tpa
Condenser dross production		10,100 tpa
Slag		
Dump slag Zinc content		13.0%
Blast Furnace slag Zinc content		13.6%
Blast Furnace slag Lead content		3.5%
Dump slag Fe_2O_3/FeO ratio		0.4
Blast Furnace slag Fe_2O_3/FeO ratio		0.3
Slag moisture content		3.0%
Coke		
Coke fixed carbon		78%
Coke moisture content		15%
Fuming Furnace		
Specific Zinc fuming rate		53 kg/hr m^2
Coke addition		stoichiometric
Fumed slag composition:	Zn	3.0%
	Pb	0.2%
	S	1.8%
Alloy formation		6000 tpa
Composition	Fe	90%
	S	3.0%
	Zn	0.4%
	Pb	0.4%
	Others	6.2%
Off-gas Conditions		
CO to CO_2 ratio (molar basis)		8

The operating factor is based on experience with furnace operations and off-gas handling systems and allows for a two week annual shut down, as well as periodic maintenance shutdowns for accretion removal.

The quantity and composition of the blast furnace slag were provided by Brunswick based on it's estimation of the blast furnace performance with the new feed composition proposed for this project. The quantity of slag fed produces a total of 26,000 tpa of Prime Western zinc.

The quantities of blue powder and dross produced are representative of ISP condenser performance assuming approximately 85% condenser efficiency. The results of the ISP engineering study indicate ISP's belief that 90% efficiency is achievable, so the quantities assumed are conservative.

The dump slag zinc content is representative of the pile to the north of the smelter, which is the initial source of slag assumed for this study.

Slag moisture content is based on samples of granulated slag that have naturally dewatered on the slag granulation pad prior to being trucked to disposal. Dump slag moisture content is typically less than 3% but 3% is assumed as a conservative overall average value.

A higher iron oxidation level (0.4 Fe_2O_3 / Fe) ratio rather than 0.3) has been assumed for dump slag.

The fixed carbon content and moisture level in the coke has been furnished by Brunswick based on the anticipated supply to the plant.

The fuming furnace performance in terms of the zinc fuming rate is based on an analysis of the pilot tests at Mintek and is based upon the fuming rate at an acceptable power density (430 Kw/m^2).

The zinc content of the fumed slag is set to provide an optimum economic performance of the fuming furnace. Operating at low zinc levels increases zinc recovery but reduces process efficiency by increasing metal alloy formation and increases equipment size. Brunswick's analysis is that 3% Zn in slag presents an acceptable compromise but lower zinc content may possibly be achieved.

The composition of other components in the slag and of the metal alloy are based on analysis of Mintek test results, consistent with thermodynamic considerations.

The CO/CO_2 ratio is based on allowing for some CO loss by oxidation from the 10/1 CO/CO_2 ratio theoretically predicted in order to be conservative in the design of the furnace off-gas system.

6. PROCESS DESCRIPTION

Material Feed and Drying

The feed material for the slag fuming installation is granulated blast furnace slag, which is produced when the slag being tapped from the blast furnace is contacted by high energy water droplets. The slag is granular (60% of weight consists of particles between 0.5 and 1.5mm), with a minimum of fines. There are two sources of the feed material: present production which is recovered from the slag granulation dewatering pad ("BF slag"); and material which is recovered from thirty years of stockpiling ("dump slag"). When the slag fuming operation is in place the composition of the BF slag will reflect the new, higher zinc, feeds to the smelter as well as the by-products (blue powder and condenser dross) that will be recycled back to the sinter plant. Although there will be modest differences in composition between the two materials, no attempt to blend the two slags will be required, other than the natural blending that will occur in storage and processing.

The reductant for the process is coke, which can consist of coke fines or coke breeze, as long as it contains a minimum dust content.

For the purpose of this study it has been assumed that condenser dross and blue powder, as well as all secondary feed materials, pass through the sinter plant and blast furnace. These miscellaneous materials may be treated directly in the fuming furnace, but the ability to do so has not as yet been demonstrated. A feed bin for miscellaneous materials has been provided for this eventuality.

It may be desirable to adjust the slag basicity by adding a flux (either lime or silica). Although this has not yet been proven necessary in pilot testing and is not part of the feasibility study design, the miscellaneous feed bin could be used for flux feeding to the furnace if required.

It is essential to dry all feed materials (slag, coke, miscellaneous materials, and flux, if utilized) as water will react to form hydrogen and convert zinc to zinc oxide in the condenser. Slag and coke dryers will be designed to eliminate moisture (< 0.1% H_20). The fuel for the dryers will be the cleaned CO containing gas produced in the fuming furnace (LCV gas) with #2 fuel oil as a back-up.

Fuming Furnace

The fuming reactions occur in a 35MW DC fuming furnace with a single center electrode. The furnace design is intended to promote good mixing and high reaction rates. The continuously fed cold slag melts and reacts with the coke. Reactions that occur include the reduction of zinc and lead oxides and sulphides to metals, and the reduction of higher oxides of iron to FeO. Zinc oxide reduction occurs preferentially to ferrous oxide reduction, but as the zinc concentration is depleted, ferrous oxide is reduced in greater quantities and an iron alloy is formed containing some zinc and lead as well as other impurities. At the proposed 1400 - 1450^{0}C operating temperature, the zinc metal produced is vaporized, but a small quantity of lead may remain and form bullion in the furnace.

The slag formed in the furnace is continuously tapped. It is believed that this slag would be stable when tested in accordance with USEPA TCLP leach testing methods. The slag will be granulated by sea water and pumped to the slag disposal area, where the sea water will self drain back to the Bay of Chaleur.

The iron alloy formed in the fuming furnace will be intermittently tapped and cast into blocks for disposal. Lead bullion will be tapped from the furnace as required and cast into blocks for further processing in the lead refinery.

Lead Splash Condenser

The furnace off-gas bearing Zn and Pb fume exits the furnace at 1400 - 1450^{0}C. The hot gas is contacted by a cooling spray of lead droplets in the ISP lead splash condenser. The majority of the Zn and Pb fume is absorbed by the lead and condensed to molten metal. The zinc-bearing lead is pumped to an enclosed launder where it is cooled from about 540^{0}C to 450^{0}C using banks of water cooled pins. At the lower temperature, the zinc is less soluble in lead and forms a separate layer, and subsequently overflows into a liquation bath. By cooling to about 450^{0}C, the lead content of the zinc is reduced to less than 1.3%. The zinc is treated to remove impurities following which it is stored in a holding bath. Lead is recirculated and occasionally tapped for casting into blocks and sent to the lead refinery. Zinc is cast into slabs and stored for shipping. Oxidized forms of lead and zinc as well as other impurities accumulate in the condenser as condenser dross. These are collected and recycled to the sinter plant.

Off-Gas Handling System

The remaining particulate and vapour leaving the condenser is treated by a scrubbing system consisting of a quench tower followed by a venturi scrubber and mist eliminator to allow the gas to be used as a low-calorific-value (LCV) fuel gas. The quench tower cools the gas from 470^{0}C to 35^{0}C using recycled water. The LCV gas is used as the fuel source in the rotary dryers to dry the slag and coke; the rest will be utilized for other heating operations in the smelter. A combustion chamber is located after the mist eliminator to combust the CO bearing gas in the event that the LCV gas cannot be sent to the dryers or other users. The combustion chamber

has sufficient capacity to handle all of the LCV bearing gas. This assures that all gaseous emissions are fully oxidized prior to being discharged to the baghouse.

The quench tower and scrubber underflow is pumped to a clarifier for the settling of the particulate, known as blue powder. The blue powder contains approximately 40% zinc and 17% lead, and will be recycled to the sinter plant. The clarifier underflow is pumped to the existing sinter plant clarifier for further treatment and recovery of the blue powder solids. The overflow is recycled to the quench tower and scrubber.

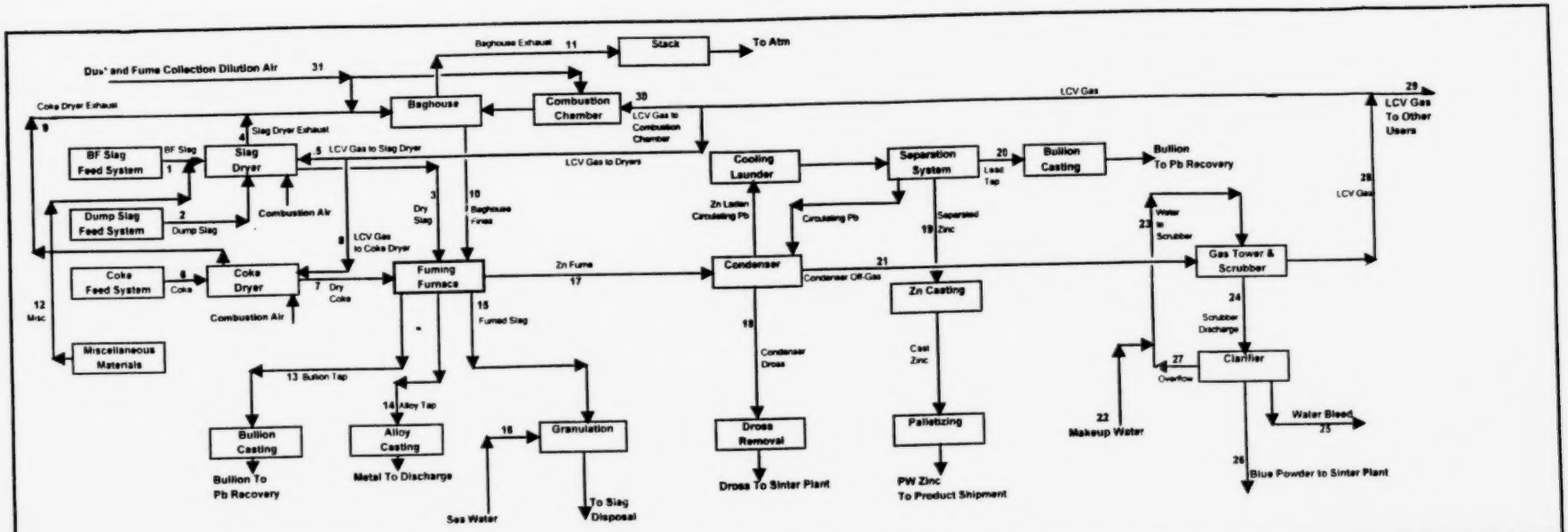
Plant Hygiene System

Dust and fume control systems are provided at all potential emission points in the plant. The volume of air contained in the dust and fume collection system will be combined with and used as tempering air for the gas streams exiting the combustion chamber and the dryers and will be vented to a new common baghouse for emission control prior to discharge.

6.1 Plant Material Balance

A material and energy balance model for the performance of the slag fuming installation was developed, based on the following: 1) a spreadsheet model of the existing installation with a new feed composition and recycles, developed by Brunswick; 2) Information from previous test work, described in Mintek reports; 3) Equipment performance predictions by Mintek and ISP; 4) Fundamental metallurgical and thermodynamic principles. The plant material balance based on this model is shown on the Schematic Flow Sheet. A summary of the distribution of the major elements is shown on the Elemental Material Balance table.

The balances show that 145,000 tpy of BF slag and 130,000 tpy of dump slag are processed to produce 26,000 tpy of Prime Western Zinc, 6000 tpy of iron alloy, and 2100 tpy of lead bullion. 217,000 tpy of discard slag is created and 14,900 tpy of material is recycled (10,100 of condenser dross and 4,800 of blue powder) to the sinter plant.



Components	Mol. Wt.	Units	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
PbO	223.2	kg/h	656	785	1441	7	0	0	0	0	0	7	0	0	0	0	66	0	7	198	0	0	125	0	0	125	0	125	0	0	0	0	0
ZnO	81.38	kg/h	2509	2114	4624	23	0	0	0	0	0	23	0	0	0	0	1139	0	24	298	0	0	337	0	0	337	0	337	0	1	0	0	0
ZnS	97.44	kg/h	1111	996	2107	11	0	0	0	0	0	11	0	0	0	0	0	0	11	1	0	0	10	0	0	10	0	10	0	0	0	0	0
FeO	71.85	kg/h	4496	4902	9398	47	0	0	0	0	0	47	0	0	0	0	10678	0	48	3	0	0	45	0	0	45	0	45	0	0	0	0	0
Fe2O3	159.7	kg/h	1798	1471	3269	16	0	0	0	0	0	18	0	0	0	0	0	0	17	1	0	0	18	0	0	16	0	16	0	0	0	0	0
CaO	56.08	kg/h	3086	2913	5999	30	0	10	10	0	0	30	0	0	0	0	7818	0	40	3	0	0	37	0	0	37	0	29	0	0	0	0	0
SiO2	60.08	kg/h	3756	4006	7762	39	0	96	95	0	1	40	0	0	0	52	3888	0	20	1	11	0	19	0	0	19	0	19	0	0	0	0	0
others	70.78	kg/h	2789	1021	3810	19	0	152	150	0	2	21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C	12.00	kg/h	0	0	0	0	0	1178	1167	0	12	12	0	0	0	0	0	0	4183	102	3591	0	0	0	0	0	0	0	0	0	0	0	0	0
Zn	65.38	kg/h	0	0	0	0	0	0	0	0	0	0	0	0	0	134	3	0	1234	736	43	182	0	0	0	0	0	0	0	0	0	0	0
Pb	207.20	kg/h	102	0	102	0	0	0	0	0	0	0	0	0	0	0	756	0	0	0	0	0	0	0	0	0	0	0	0	2488	1598	0	0
Fe	55.85	kg/h	0	0	0	0	0	0	0	95	0	0	0	0	0	0	0	0	2488	0	0	0	2488	0	0	0	0	0	0	0	0	0	0
CO(g)	28.00	kg/h	0	0	0	0	797	0	0	0	0	0	0	0	0	25	0	0	138	70	0	0	54	0	0	54	0	54	0	0	0	0	0
S	32.04	kg/h	0	0	0	0	0	0	0	0	0	0	0	0	0	0	486	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CaS	72.08	kg/h	0	0	0	0	0	0	0	0	0	0	0	0	0	0	889	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FeS	87.89	kg/h	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0	0	0	7	5	0	0
PbS	239.20	kg/h	0	0	0	2	2	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	489	0	0	0	0	0	0	489	314	0	0
SO2	64.00	kg/h	0	0	0	2	2	0	0	0	1	0	0	0	0	0	0	0	489	0	0	0	497	0	0	0	0	0	0	497	319	0	0
CO2	44.00	kg/h	0	0	0	1565	157	0	0	19	188	0	0	0	0	0	0	0	497	0	0	0	0	0	0	0	0	0	0	0	0	0	0
N2	28.00	kg/h	0	0	0	8926	159	0	0	19	828	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
O2	32.00	kg/h	0	0	0	1519	0	0	0	0	181	0	0	0	0	0	0	0	0	0	0	0	40	3355	110000	110000	0	3355	108645	130	84	0	0
H2O	18.00	kg/h	628	563	39	1378	42	264	1	5	287	0	0	0	0	0	0	417000	40	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nat. Gas	16.00	kg/h	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C2H4	28.00	kg/h	0	0	0	0	0	0	45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
H2	2.00	kg/h	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total		Kg/h	20931	18770	38550	11583	1159	1759	1481	139	1498	207	0	0	134	840	30461	417000	9273	1415	3645	182	4199	3355	110000	110671	0	4026	108645	3618	2321	0	0
Temp		C	amb	amb	100	165	35	amb	100	35	135	25		amb	1450	1450	1450	amb	1450	450	450	450	470	amb	25	30	25	25	25	35	35	35	
Nor. Flow			20931	18770	38550	9117	920	1759	1481	110	1242	207			134	840	30461	417	4421	1415	3645	182	2781	3	110	111	0	3	107	2873	1843	3000	110 000
Design Flow							1300			150			120000						5600				4000										

*** Gases in Nm3/hr
Liquids in m3/hr
Solids in Kg/hr

Rev	Approval	Issued For	By	Date
3		Cost Estimate	KW	11/12/97
2		Information	KW	25/11/97
1		Client Review	VR	13/11/97
0		Client Review	VR	22/10/97

HATCH

BRUNSWICK SMELTING
BLAST FURNACE SLAG FUMING FEASIBILITY STUDY
Schematic Flow Sheet & Material Balance using all Cold Feed
Project No 16855

TABLE 6-1 - Elemental Material Balance : All Cold Slag to Fuming Furnace

	tpy	tph	% Zn	tpy Zn	% Zn Distrib'n	% Pb	tpy Pb	% Pb Distrib'n	%Fe	tpy Fe	% Fe Distrib'n	%S	tpy S	% S Distrib'n
IN														
BF Slag (including recycle streams)	144967	20 3	13 6%	19716	53 8%	3 5%	5074	49 4%	23 4%	33932	49 5%	1 8%	2608	52 7%
Dump Slag	130000	18 2	13 0%	16900	46 2%	4 0%	5200	50 6%	26 6%	34550	50 5%	1 8%	2339	47 3%
TOTAL IN	**274967**	**38.5**		**36616**			**10274**			**68482**			**4946**	
OUT														
PWG Zn	26024	3 6	98 5%	25639	70 0%	1 2%	308	3 0%	0 0%	0	0 0%	0 0%	0	0 0%
Blue Powder Recycle	4793	0 7	41 3%	1979	5 4%	17 3%	829	8 1%	6 8%	326	0 5%	8 6%	410	8 3%
Condenser Dross	10100	1 4	24 1%	2434	6 6%	65 0%	6565	63 9%	0 2%	25	0 0%	5 0%	505	10 2%
Fumer Pb Bullion	955	0 1	0 0%	0	0 0%	100 0%	955	9 3	0 0%	0	0 0%	0 0%	0	0 0%
Fumer Iron Alloy	6000	0 8	0 4%	24	0 1%	0 4%	24	0 2%	90 0%	5400	7 9%	3 0%	180	3 6%
Condenser Excess Pb	1156	0 2	0 0%	0	0 0%	100 0%	1156	11 3%	0 0%	0	0 0%	0 0%	0	0 0%
Discard Slag	217488	30 5	3 0%	6536	17 9%	0 2%	436	4 2%	28 8%	62731	91 6%	1 8%	3856	77 9%
TOTAL OUT	**266516**	**37.3**		**36612**	**100.0%**		**10273**	**100.0%**		**68482**	**100.0%**		**4951**	**100.0%**

BRUNSWICK SMELTING
BLAST FURNACE SLAG FUMING FEASIBILITY STUDY
Revision 3
Date 12/11/97
Project No. 16855

HATCH

Of the zinc in the slag being processed, 70% is recovered as Prime Western Zinc, 18% is lost to discard slag and 12% is recycled.

Although lead recovery is not a prime objective of slag fuming, the balance shows about 21% of the lead in the slag will be directly recovered as bullion to the lead refinery, 72% will recycle (mostly as condenser dross), and about 7% will be lost to the zinc and iron products and the discard slag.

7. PLANT DESCRIPTION

Reference: General Arrangement Dwgs: 16855-AO-G-001, 002, 003, 004, 005, 006
Mechanical Flowsheets: 16855-00-F-001, 002, 003

7.1 Plant Location

The main process building is located north of the charge preparation building and northwest of the blast furnace building and south of the maintenance shops. This location minimizes disruption to plant vehicle traffic. Relocation of the east-west trestle passing through this area is not required, but about 200 feet of the north south trestle must be relocated. In addition, underground utilities located in the area will require relocation. In general, the building is near the maximum size that can comfortably occupy the available space.

Slag handling and storage will be located in the space presently occupied by a fuel oil tank and it's containment, requiring some demolition. The plant cooling tower will also be located in this area.

A new clarifier and associated equipment is located adjacent to the existing sinter plant clarifier which will receive the underflow from the new one.

The coke unloading, coke and slag drying, and plant baghouse are located to the west of the main process building.

The new facility will utilize existing plant structures and facilities where applicable, including granulated slag trestles and utility tie-ins.

7.2 Feed and Drying

Slag Feed Equipment

A 40 tonne (1 hour) capacity slag dump hopper with grizzly is provided for receiving BF and dump slag from dump trucks. The hopper is located in a shed and discharges to a vibratory feeder which feeds the wet slag belt conveyor. This conveyor transfers the wet slag to the top of the slag storage dome.

The 85 foot diameter slag storage dome provides 12 hours of active storage capacity. Two vibratory feeders discharge material on to the slag reclaim belt conveyor. Provision is made so that miscellaneous materials may also be discharged on to the slag reclaim belt conveyor. The wet slag is then transferred to the slag dryer feed conveyor.

The baghouse is provided with two exhaust fans which discharge to a single stack. The Table 7-1 indicates the design allowances for dust & fume control.

Coke Feed Equipment

A twelve hour capacity coke hopper with grizzly is provided to receive coke from dump trucks. The hopper is located in a shed and discharges to a vibratory feeder which feeds a coke bucket elevator that directly discharges to the coke dryer.

Slag and Coke Drying

Slag and coke are dried in separate co-current direct fired rotary dryers to a moisture content of less than 0.1% H_2O. The primary fuel for the dryers is the cleaned CO-containing LCV gas produced in the fuming furnace, with #2 oil as a back-up fuel.

Furnace Feed

The two dryers discharge on to flexible wall conveyors which convey the materials to storage bins above the fuming furnace. The slag storage bin is designed for 4 hours of storage and discharges to a slag weigh bin on load cells which has about 1.5 hours of capacity. The coke storage weigh bin has 12 hours of capacity. The slag flexible wall conveyor is also designed to discharge to a miscellaneous material weigh bin on load cells, for materials other than slag that may be fed to the furnace.

Each of the three weigh bins has three bottom discharges, each supplying a furnace feed screw conveyor. Three furnace feed port openings are provided at the top of the furnace, located equidistant around the centre electrode. The feed of slag will be controlled by the weigh feeders and the feed coke (and other material) will be automatically proportioned to the slag feed.

TABLE 7-I - DUST AND FUME CONTROL

Assumptions: air velocity through the gap between suspended hood and equipment: 100 FPM
air velocity through openings (doors, etc) 200 FPM
air velocity through enclosure opening 200 FPM
air flow rate for conveyor transfer point (belt speed 200ft/min) 500 CF/min per FT. belt width
air flow rate for screens 200 CF/min per SF hood opening

No	PICK-UP POINT	QUANTITY	TYPE	DIMENSIONS					FLOW
				Length [FT]	Width [FT]	Perimeter [FT]	Height [FT]	Area [SF]	[CFM]
1	Slag Storage Bin	1	enclosure		2.5				1,250
2	Furnace Fe Alloy Tapping	1	enclosure	8	3			24	4,800
3	Fe Alloy Ladle	1	hood			19	1	19	2,660
4	Furnace Pb Tapping	1	enclosure	8	3			24	4,800
5	Pb Block Casting	1	hood			19	1	19	2,660
6	Furnace Slag Tapping	1	enclosure	8	3			24	4,800
7	Furnace Slag Tapping	1	enclosure	8	3			24	4,800
8	Dross Extractor Conveyor Feed	1	enclosure		2.5				1,250
9	Condenser Cooling Launder	1	hood	36	4	80	1	80	11,200
10	Condenser Cleaning Doors	4	hood	3	3	48	1	48	6,720
11	Condenser Separation Bath	1	hood	6	6	24	1	24	3,360
12	Condenser Liquation Bath	1	hood	6	12	36	1	36	5,040
13	Condenser Zn Casting Bath	1	hood	10	8	36	1	36	5,040
14	Condenser Skiming Sump	1	hood	8	4	24	1	24	3,360
15									
16	Condenser Pb Block Casting	1	hood			19	1	19	2,660
17	Condenser Zn Casting Launder	1	hood	4	4	16	1	16	2,240
18									
19									
20	Dross Extractor	1	hood	10	8	36	1	36	5,040
22	Coke Dryer Feed	1	enclosure		2.5				1,250
23	Dry Coke Bin	1	enclosure		2.5				1,250
24	Slag Dryer Feed	1	enclosure		2.5				1,250
25	Slag Hopper Shed	1	hood	10	10	40		100	10,000
26	Slag Hopper Vib. Feeder	1	enclosure	4	4	16	1	16	3,200
27	Slag Hopper Conveyor Feed	1	enclosure		2.5				1,250
28	Slag Storage Dome	1	hood	10	10	40	1	100	10,000
29	Slag Dome Vib. Feeder	2	enclosure	4	4	32	1	16	6,400
30	Slag Dome Conveyor Feed	2	enclosure		2.5				2,500
31	Coke Shed	1	hood	10	10	40		100	10,000
32	Coke Conveyor Feed	1	enclosure		2.5				1,250
	Furnace Enclosure	1	enclosure						60,000
	Dryer Exhaust	1	enclosure						10,000
	TOTAL								190,030

Use 200,000 FPM for Design

Fuming Furnace

The internal diameter of the fuming furnace, 10 m, is based on the pilot test results and corresponds to a zinc fuming rate of 53 kg / hr/m^2.

The circular furnace has dimensions given in Table 7-2 (see furnace cross-section, Figure 16855-SK 001).

Table 7-2: Furnace Dimensions

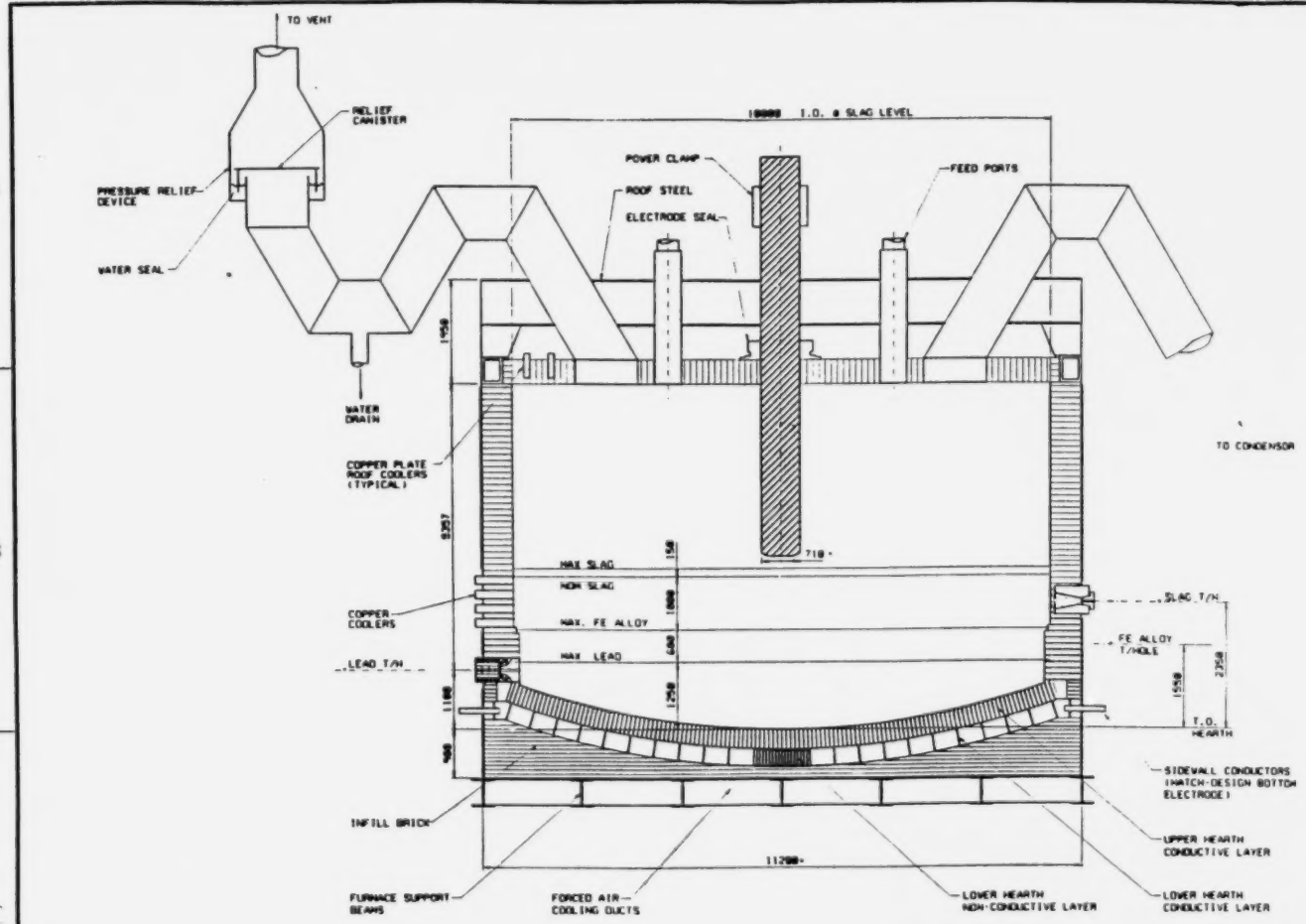
	Dimension	Basis
Inside Diameter (hot face to hot face)	10 m	Hearth Power Density = 430 kW/m^2
Outside Diameter	11.2 m	Wall Thickness = 0.6 m
Maximum bath depths: ➢ lead ➢ iron speiss ➢ slag	 0.15 m above tap hole 0.6 m 1.15 m	Bath level rise rates: < 1 cm per day 5 cm per day 13 cm per hour (nearly continuous slag tapping assumed)
Freeboard Height (top of slag to bottom of roof)	3.5 m	Client request
Overall Height (bottom shell to top of roof steel)	approximately 9.3 m	

Furnace Steelwork

The furnace steelwork envisioned would include a segmented cylindrical shell (25 mm thick steel plate), tied together with adjustable bindings. This technique would allow the application of compressive forces to the brick work during both heating and cooling stages - a significant improvement over traditional rigid shell circular furnaces which are prone to ratcheting or bottom brick float-out.

Furnace Sidewalls

For the given hearth power density (430 kW/m^2), full slag zone copper cooler coverage is recommended. The cost estimate includes four rows of 150 mm square finger coolers for the furnace sidewalls.



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REVISIONS				

NO.	ISSUE FOR	AUTH. BY	DATE
ISSUE AUTHORIZATION			

DESIGNED BY J. SARVINIS	DRAWN BY BRAGANZA
DATE	DATE 97.12.09
CHECKED BY	DISCIP. ENGR.
DATE	DATE
PROJ. MGR.	PROJ. ENGR.
DATE	DATE

HATCH

SCALE: OR AS NOTED

BRUNSWICK SMELTING
35 MW DC SLAG FUMING FURNACE
CROSS SECTION

DRAWING NO. 16855-SK-001 | SHT. | REV.

Furnace Roof

The estimate provides for low iron bricks necessary for the high CO gas environment, as well as copper plate coolers at approximately 400 mm centers. This design offers improved refractory life while mitigating somewhat the high heat loss that would be experienced with a full water jacket type of design.

Furnace Hearth

The furnace hearth would consist of a mechanically tight inverted dome to maintain crucible integrity.

The cost estimate accounts for a hearth anode design involving the use of lower sidewall copper coolers as the return conductors. The design, for which HATCH has a patent pending, has been demonstrated successfully in a 350 kW prototype.

Tapping

Since slag tapping will be nearly continuous, two slag tap holes are recommended for reliability. Each tap hole would have a water-cooled copper slag launder (slag running directly on copper, no refractory lining). The two launders are routed to one granulation point. The slag tap holes would be serviced by a mudgun/drill unit.

Lead and iron speiss will be tapped through two separate tap holes, each with its own refractory lined launder. The lead and iron speiss tap holes would be serviced by a single mudgun/drill unit.

Electrode Column

Electrical power will be supplied to the furnace via a 28" (710 mm) pre-baked graphite electrode. The cost estimate includes:

- electrode column main hoist cylinders with the associated hydraulic system
- power clamp and automatic slipping clamp with associated cylinders and hydraulics
- telescopic electrode seal (to contain CO gas under positive pressure and prevent air ingress when furnace is under suction)
- start-up electrode mast and arm

There will be a lay down area for electrode storage at an elevation close to the top of the furnace roof. Electrode segment addition will be handled by a 15t crane located above the furnace.

Furnace Pressure Relief

A water seal pressure relieving device is provided to discharge furnace gases to atmosphere through a stack in case of pressure surges above the furnace design pressure. The design of this device is based on similar experience for positive pressure furnaces with a CO containing atmosphere.

Basis of Furnace Estimate

Cost estimates from previous Hatch designs for circular furnaces were scaled up/down based on their dimensions relative to those of this furnace.

The roof estimate was scaled down from a +/- 10% estimate for a 14 m outside diameter furnace. The remainder of the estimate was scaled up from a +/- 25% estimate for a 9.5 m outside diameter furnace. The costs were scaled on an item by item basis using an appropriate volume, surface area or perimeter based factor.

7.3 Electrical System

(Reference Dwg. 16855-SK-E-001)

The plant electrical system has to be expanded to accommodate the 35 MW DC furnace as well as the additional AC power required for the new facility. The expansion also has to assure that reliable back-up power is retained for all existing as well as new facilities. After considering a number of options for new transformer configurations, the following option was selected.

A new 138 / 4.16 KV transformer will be installed in parallel to the two existing main power transformers at the main substation. The substation will be modified to accommodate new high voltage breakers and 5 KV switchgear.

The 4.16 KV power will directly power 4 KV motors (an allowance for 5 has been made) as well as supply to 4.16 KV/600 V unit substations located in the process area.

A new 138/25 KV transformer will be installed at the substation to supply the DC furnace. A back-up transformer will be purchased but not installed.

Furnace Electrical System

A 20 MVAR main subharmonic filter, located at the main substation, has been provided for line protection.

The power supply for the furnace includes two twin thyrister rectifiers, two sets of flexible AC bus, one DC twin reactor, one local rectifier control, one high voltage switchgear and a 25 kV transformer, with a spare transformer. A complete DC bus system including 320 m. of bus is included.

7.4 Slag Granulation

The continuously tapped slag from the furnace is contacted with a high energy spray of sea water droplets in a launder to granulate the slag. An additional sea water pump will be supplied at the existing sea water intake for the additional sea water required for this service and booster pumps supplied to achieve the pressure required at the spray nozzles. An emergency granulation tank will be supplied in case of pump failure. The slag granulation slurry will be collected in a sump and granulated slag pumps supplied to pump to the slag pile, where the pile will self-dewater.

7.5 ISP Supply

The vapors leaving the furnace go through a refractory lined duct to the lead splash condenser. The lead splash condenser, zinc and gas scrubbing system are described in "a Preliminary Design Study for a Lead Splash Condenser System," prepared by ISP for Brunswick.

7.6 Dross and Blue Powder

The dross collected in the lead splash condenser will be collected in containers, allowed to cool and transported for recycling to the sinter plant.

The slurry collected in the off-gas scrubbing system will be pumped to a blue powder clarifier. The clarifier overflow will be collected in an overflow tank. Scrubber make-up water will be added, as required and the scrubbing solution will be recycled back to the scrubbing system by scrubber recycle pumps after being cooled in a recycle scrubber cooler. The clarifier underflow, containing scrubbed solids (blue powder), will be pumped by the underflow pumps to the existing sinter plant clarifier.

7.7 Cooling Tower

Indirect contact cooling water for furnace cooling , condenser cooling, scrubber condenser cooling and miscellaneous uses will be collected in a 5000 gpm cooling tower. The cooling tower will have two cooling water supply pumps for delivery to the plant users. Two sets of pumps, one for cooling water return and one for cooling tower feed will be furnished.

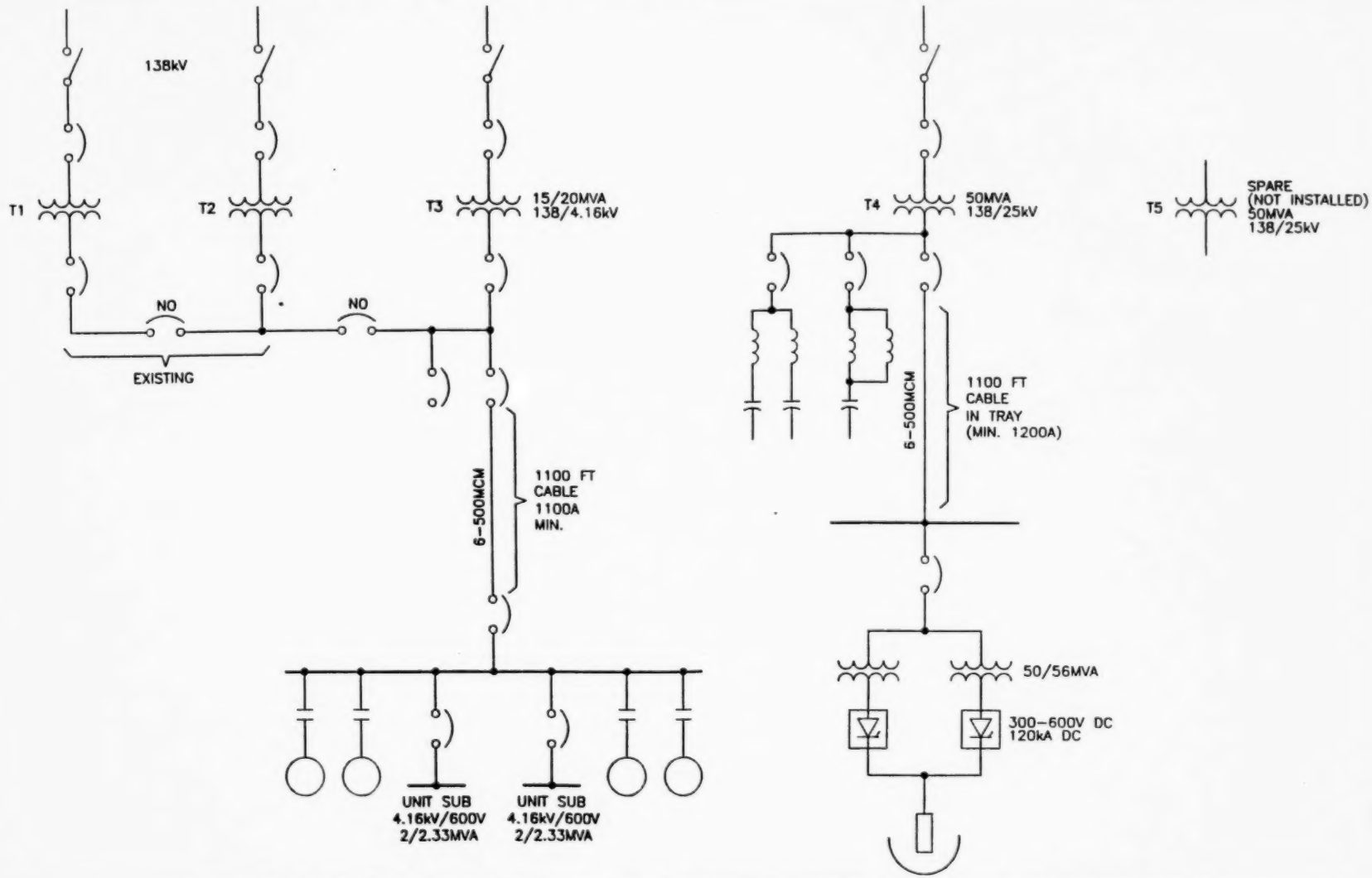
7.8 Process Building

The process occupies approximately 18,000 ft^2 of plant area. The main building is 175' x 90' with a peak height of 100' in the furnace area and 55' in the zinc condenser area. The drying building is 80' x 34' with a 30' high roof.

The building is provided with lighting and HVAC services as well as three roll-up doors and a maintenance elevator. One 15 ton and two 5 ton cranes are provided to service the furnace and condenser. Two transformer rooms and two electrical rooms are provided as well as a control room, break room, and foreman's office.

7.9 Dust & Fume Control

Pick up points for all potential dust and fume emissions are ducted to a new 200,000 cfm plant baghouse along with the dryer exhausts. A combustion chamber is provided to oxidize unutilized LCV gas prior to discharge to the baghouse.



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REVISIONS				

NO	ISSUE FOR	AUTH. BY	DATE
ISSUE AUTHORIZATION			

DESIGNED BY	DRAWN BY T. TSAO
DATE	DATE 97/12/09
CHECKED BY	DISCIP. ENGR.
DATE	DATE
PROJ. MGR.	PROJ. ENGR.
DATE	DATE

HATCH

SCALE OR AS NOTED

BRUNSWICK SMELTING
NORANDA MINING AND EXPLORATION INC.
BRUNSWICK SMELTING DIVISION BELLEDUNE

BLAST FURNACE SLAG FUMING FEASIBILITY STUDY

ELECTRICAL SINGLE LINE DIAGRAM

DRAWING NO. 16855-SK-E-001 SHT.

8. CAPITAL COST ESTIMATE

The capital cost estimate for the slag fuming facility is $93,000,000. (CDN).

The methodology used in developing this estimate is described in the Appendix and includes a risk analysis for establishing the contingency to be applied to the estimate.

Not included in the estimate is any process contingency for changes that might occur as a result of additional test or process development work.

The attached sheets summarize the estimate by plant area and discipline.

Table 8-1: Capital Cost Summary

DIRECT COSTS	($000)	($000)
Site Preparation	650	
Electrical Supply	4,698	
Feed Preparation, Drying and Supply	4,187	
Electric Furnace	23,030	
Zinc Recovery and Casting	5,990	
Building	5,995	
Fume & Dust Control	7,021	
Utilities - Slurry, Water, Air	2,643	
Miscellaneous Equipment Purchases	235	
TOTAL DIRECT COSTS		**54,449**
INDIRECT COSTS		
E.P.C.M.	10,890	
Freight, Vendor Assist, Temp. Svcs.	3,351	
Owners Project Management & Training	1,872	
Know-How / Licensing Fees	2,500	
TOTAL INDIRECT COSTS		**18,613**
Total Identified Cost		**73,062**
Contingency @ 27.3%		**19,938**
TOTAL PROJECT COST		**$93,000**

HATCH

BRUNSWICK MINING AND SMELTING
SLAG FUMING FEASIBILITY STUDY
PROJECT 16855

BY: KIRAN JANI

DATE: 2/26/98

Cost Code	WBS	Matrix Code	Equip Type	ID	ITEM DESCRIPTION	QTY	UNIT	UNIT MATERIAL COST	TOTAL MATERIAL COST	UNIT LAB HRS	TOTAL LAB HRS	LABOUR RATE ($/HR)	TOTAL LAB COST	TOTAL COST	RISK CODE
A	A1A				DEMOLITION										
A	A1A	A		1	Oil Tank & Berm	1	Lot	5,000	5,000		250	60.00	15,000	20,000	F
	A1A Total								5,000		250		15,000	20,000	
A	A1B	A		2	General Site Preparation, Clearing and Grubbing	1	Lot		50,000		833	60.00	50,000	100,000	F
	A1B Total								50,000		833		50,000	100,000	
A	A1C	A		3	Roads & Paving	1	Lot		5,000		83	60.00	5,000	10,000	F
	A1C Total								5,000		83		5,000	10,000	
A	A1D				RELOCATION										
A	A1D	Q		4	N/S Trestle and Underground Utilities Allowance	1	Lot	250,000	250,000		4,167	60.00	250,000	500,000	F
	A1D Total								250,000		4,167		250,000	500,000	
A	A1F	A		5	Drainage	1	Lot	10,000	10,000		167	60.00	10,000	20,000	F
	A1F Total								10,000		167		10,000	20,000	
H	C1D				NON-CONTACT COOLING WATER										
H	C1D	C		6	Hot Well/Cold Well 25'x40' c/w Pumps Support	1	Lot	90,000	90,000		1,500	60.00	90,000	180,000	D
H	C1D	C		7	Cooling Water Foundations	1	Lot	50,000	50,000		833	60.00	50,000	100,000	D
H	C1D	J		8	C Water PreEngrd Building 20'x30'	1	Lot	30,000	30,000		500	60.00	30,000	60,000	D
H	C1D	L		9	3" CS-Sch 40 Pipe c/w Valves	420	ft	82	34,400		573	60.00	34,400	68,800	D
H	C1D	L		10	14" CS-Sch 40 Pipe c/w/ Valves	1,200	ft	219	262,900		4,382	60	262,900	525,800	D
H	C1D	MP		11	Cooling Tower 5000 GPM	1	ea	95,000	95,000		850	60.00	51,000	146,000	D
H	C1D	MP		12	Cooling Water Supply Pumps 175 HP	2	ea	50,000	100,000		100	300.00	30,000	130,000	D
H	C1D	MP		13	Hot Well/Cold Well Pumps 60HP	4	ea	50,000	200,000		100	300.00	30,000	230,000	D
H	C1D	U		14	Process Electrics	1	Lot	63,000	63,000		783	60.00	47,000	110,000	D
H	C1D	V		15	Process Control	1	Lot	79,000	79,000		1,250	60.00	75,000	154,000	D
	C1D Total								1,004,300		10,872		700,300	1,704,600	
H	C1E				SEA WATER										
H	C1E	D		16	Trestle	500	ft	102	51,200		4,245	60.00	254,700	305,900	F
H	C1E	D		17	Pipe Supports	1	Lot	18,000	18,000		100	60.00	6,000	24,000	D
H	C1E	L		18	12"&14" HDPE Piping	2,062	ft	16	33,000		887	60.00	53,200	86,200	D
H	C1E	L		19	Fittings	1	Lot	15,000	15,000		83	60.00	5,000	20,000	D
H	C1E	L		20	Equipment Rental	1	Lot	1,000	1,000		112	60.00	6,700	7,700	D
H	C1E	L		21	Sea Water Supply Pumps	1	Lot	50,000	50,000		833	60.00	50,000	100,000	F

HATCH

BRUNSWICK MINING AND SMELTING
SLAG FUMING FEASIBILITY STUDY
PROJECT 16855

BY: KIRAN JANI

DATE: 2/26/98

Cost Code	WBS	Matrix Code	Equip Type	ID	ITEM DESCRIPTION	QTY	UNIT	UNIT MATERIAL COST	TOTAL MATERIAL COST	UNIT LAB HRS	TOTAL LAB HRS	LABOUR RATE ($/HR)	TOTAL LAB COST	TOTAL COST	RISK CODE
H	C1E	L		22	Sea Water Booster Pumps & Piping	2	lot	50,000	100,000		833	60.00	50,000	150,000	F
	C1E Total								**268,200**		**7,093**		**425,600**	**693,800**	
H	C1F				**FIRE PROTECTION WATER**										
H	C1F	L		23	Fire Protection Water	1	Lot		10,000		167	60.00	10,000	20,000	F
	C1F Total								**10,000**		**167**		**10,000**	**20,000**	
H	C3A				**INSTRUMENT AIR**										
H	C3A	L		24	Inst Air Filter, Dryer & Piping	1	Lot	10,000	10,000		250	60.00	15,000	25,000	F
	C3A Total								**10,000**		**250**		**15,000**	**25,000**	
H	C3B				**COMPRESSED AIR**										
H	C3B	MP		25	Main Compressor+Dryer+Receiver+Piping	1	Lot	100,000	100,000		833	60.00	50,000	150,000	D
	C3B Total								**100,000**		**833**		**50,000**	**150,000**	
H	C4A				**NITROGEN**										
H	C4A	L		26	Nitrogen (Tank & Distribution) c/w Process Control	1	Lot	25,000	25,000		417	60.00	25,000	50,000	F
	C4A Total								**25,000**		**417**		**25,000**	**50,000**	
H	D1A				**EXPANSION OF SUBSTATION**										
B	D1A	NP		27	138 KV Disc c/w Towers, Foundations etc.	2	ea	100,000	200,000		1,000	60.00	60,000	260,000	D
B	D1A	NP		28	138 KV Breakers	2	ea	100,000	200,000	400	800	60.00	48,000	248,000	D
B	D1A	NP		29	15/20 MVA Transformer c/w Foundation, Oil Containment	1	ea	500,000	500,000		1,400	60.00	84,000	584,000	D
B	D1A	NP		30	Line up of 5KV Switchgear - 5 Cubicles include some Building Mods.	1	Lot	500,000	500,000		4,000	60.00	240,000	740,000	D
B	D1A	NP		31	50 MVA 138/25 KV FCE Transformer c/w Foundation, Oil Containment	1	Lot	1,300,000	1,300,000		4,000	60.00	240,000	1,540,000	D
B	D1A	NP		32	50 MVA 138/25 KV (Spare included in Working Capital)	1	ea								
	D1A Total								**2,700,000**		**11,200**		**672,000**	**3,372,000**	
B	D2A				**25 KV SUPPLY**										
B	D2A	N		33	25 KV Cable & Tray to Furnace	335	M		165,000		2,000	60.00	120,000	285,000	D
	D2A Total								**165,000**		**2,000**		**120,000**	**285,000**	
B	D3A				**4160KV/600 V SUPPLY**										
B	D3A	N		34	5 KV Cable & Tray to Unit Substations	1	Lot	140,000	140,000		2,000	60.00	120,000	260,000	D

HATCH

BRUNSWICK MINING AND SMELTING
SLAG FUMING FEASIBILITY STUDY
PROJECT 16855

BY: KIRAN JANI

DATE: 2/26/98

Cost Code	WBS	Matrix Code	Equip Type	ID	ITEM DESCRIPTION	QTY	UNIT	UNIT MATERIAL COST	TOTAL MATERIAL COST	UNIT LAB HRS	TOTAL LAB HRS	LABOUR RATE ($/HR)	TOTAL LAB COST	TOTAL COST	RISK CODE
B	D3A	NP		35	Unit Substation consisting of 5 KV Breakers	5	ea		150,000	80	400	60 00	24,000	174,000	D
B	D3A	NP		36	5-5KV Starters	5	ea		100,000	80	400	60 00	24,000	124,000	D
B	D3A	NP		37	5KV Cabling & Trays to 4KV Motors. Cable & Tray to 4KV Motors (assume 400-500Ft run).	5	ea	15,000	75,000		1,000	60 00	60,000	135,000	D
B	D3A	NP		38	Substation 5 KV/480 V 2-2 67MVA	2	ea	150,000	300,000	400	800	60 00	48,000	348,000	D
	D3A Total								**765,000**		**4,600**		**276,000**	**1,041,000**	
F	E1A				**MAIN BUILDING**										
F	E1A	C		39	Building Foundations & Slab on Grade	1,170	cuyd	275	321,800		5,362	60 00	321,700	643,500	D
F	E1A	D		40	Misc. Steel (Furnace Platform & Mudgun Support)	85	mt	3,375	286,900		1,593	60 00	95,600	382,500	D
F	E1A	D		41	Building Steel	600	t	2,475	1,485,000		7,770	60 00	466,200	1,951,200	D
F	E1A	E		42	Roofing	18,000	sqft	8	135,000		1,500	60 00	90,000	225,000	D
F	E1A	E		43	Cladding	45,410	sqft	6	272,400		3,008	60 00	180,500	452,900	D
F	E1A	F		44	Metal Roll Up Door	3	ea	20,000	60,000		250	60 00	15,000	75,000	D
F	E1A	F		45	Pressed Steel Man Doors	10	ea	1,000	10,000		83	60 00	5,000	15,000	D
F	E1A	G		46	Building Services incl. Lighting, Local Piping, HVAC, etc.	18,000	sqft	5	90,000		1,500	60 00	90,000	180,000	D
F	E1A	K		47	Heating and Venilation	1	Lot	125,000	125,000		2,083	60 00	125,000	250,000	F
F	E1A	MP		48	Elevator	1	ea	410,000	410,000		2,150	60 00	129,000	539,000	F
	E1A Total								**3,196,100**		**25,300**		**1,518,000**	**4,714,100**	
F	E1B				**CONTROL AND ELECTRICAL ROOMS**										
F	E1B	J		49	Transformer & Electrical Rooms2(25'x25')+2(25'X20') Total 2250sqft c/w A/C, heaters +(20'x30')2	3,450	sqft	92	317,400	1	2,422	60 00	145,300	462,700	D
F	E1B	J		50	Control Room & Foreman's Office	1,600	sqft	92	147,200		1,120	60 00	67,200	214,400	D
	E1B Total								**464,600**		**3,542**		**212,500**	**677,100**	
F	E1C				**CRANES**										
F	E1C	MP		51	15 Ton Crane 50' span x 70' long	1	ea	200,000	200,000		333	60 00	20,000	220,000	D
F	E1C	MP		52	5 Ton Crane c/w 25' span 40' long	1	ea	150,000	150,000		250	60 00	15,000	165,000	D
F	E1C	MP		53	5 Ton Crane 25' span x 175' long	1	ea	150,000	150,000		250	60 00	15,000	165,000	D
F	E1C	U		54	Electrification	1	Lot	6,000	6,000		67	60 00	4,000	10,000	C
F	E1C	U		55	Electrification	1	Lot	5,000	5,000		50	60 00	3,000	8,000	C
F	E1C	U		56	Electrification	1	Lot	20,000	20,000		250	60 00	15,000	35,000	C
	E1C Total								**531,000**		**1,200**		**72,000**	**603,000**	

HATCH

BRUNSWICK MINING AND SMELTING
SLAG FUMING FEASIBILITY STUDY
PROJECT 16855

BY: KIRAN JANI

DATE: 2/26/98

Cost Code	WBS	Matrix Code	Equip Type	ID	ITEM DESCRIPTION	QTY	UNIT	UNIT MATERIAL COST	TOTAL MATERIAL COST	UNIT LAB HRS	TOTAL LAB HRS	LABOUR RATE ($/HR)	TOTAL LAB COST	TOTAL COST	RISK CODE
C	E1E				**MATERIAL RECEIPT & STORAGE**										
C	E1E	C		57	Concrete - Slag Hopper	140	cuyd	300	42,000		700	60 00	42,000	84,000	D
C	E1E	C		58	Slag Storage Dome c/w Roof Connection & Lighting	1	Lot	135,000	135,000		2,250	60 00	135,000	270,000	B
C	E1E	C		59	Concrete for Unloading Area	800	cuyd	45	36,000		592	60 00	35,500	71,500	D
C	E1E	C		60	All Equipment Foundations for MTL Receipt Area Dome Towers & Tunnel	1,200	cuyd	275	330,000		5,500	60 00	330,000	660,000	D
C	E1E	D		61	Steel (Tunnel) Cover	3	t		9,600		40	60 00	2,400	12,000	D
C	E1E	D		62	Slag Hopper Shed Steel	1	ea	12,000	12,000		50	60 00	3,000	15,000	D
C	E1E	D		63	Slag Hopper	1	ea	4,000	4,000		100	60 00	6,000	10,000	D
C	E1E	D		64	Coke Hopper Shed Steel	7	mt	2,429	17,000		83	60 00	5,000	22,000	D
C	E1E	D		65	Steel-Slag Hopper	3	t	3,333	10,000		33	60 00	2,000	12,000	D
C	E1E	E		66	Roofing (Tunnel)	1100	sqft	5	5,000		63	60 00	3,800	8,800	D
C	E1E	E		67	Roofing & Siding-Slag Hopper	3,700	sqft	5	18,000		200	60 00	12,000	30,000	D
C	E1E	E		68	Coke Hopper & Shed	2,600	sqft	7	18,200		133	60 00	8,000	26,200	D
C	E1E	E		69	Coke Hopper (Roofing)	3,700	sqft	5	18,500		60	60 00	3,600	22,100	D
C	E1E	MP		70	Slag Shed Sump Pump	1	ea	5,000	5,000		40	60 00	2,400	7,400	D
C	E1E	MP		71	Slag Hopper Grizzly 4x4	1	ea	800	800		3	60 00	200	1,000	D
C	E1E	MP		72	Slag Hopper Vibrating Feeder 2HP	1	ea	15,000	15,000		50	60 00	3,000	18,000	D
C	E1E	MP		73	Wet Slag Belt Conveyor 15HP	1	ea	116,000	116,000		583	60 00	35,000	151,000	D
C	E1E	MP		74	Slag Dome Sump Pump	1	ea	5,000	5,000		40	60 00	2,400	7,400	D
C	E1E	MP		75	Dome Vibrating Feeders 2HP	2	ea	15,000	30,000		100	60 00	6,000	36,000	D
C	E1E	MP		76	Slag Dryer Belt Conveyor 10HP	1	ea	100,000	100,000		500	60 00	30,000	130,000	D
C	E1E	MP		77	Slag Dryer Feed Conveyor 5HP	1	ea	46,000	46,000		233	60 00	14,000	60,000	D
C	E1E	MP		78	Coke Storage Hopper	1	ea	15,000	15,000		117	60 00	7,000	22,000	D
C	E1E	MP		79	Coke Shed Sump Pump	1	ea	5,000	5,000		40	60 00	2,400	7,400	D
C	E1E	MP		80	Coke Hopper Grizzly (4x4)	1	ea	1,000	1,000		17	60 00	1,000	2,000	D
C	E1E	MP		81	Coke Dryer Belt Feeder 3HP	1	ea	35,000	35,000		167	60 00	10,000	45,000	D
C	E1E	MP		82	Coke Elevator 5HP	1	ea	25,000	25,000		100	60 00	6,000	31,000	D
C	E1E	MP		83	Miscellaneous Bin Transf Conveyor 5HP	1	ea	20,000	20,000		100	60 00	6,000	26,000	D
C	E1E	MP		84	Miscellaneous Bin 40T	9	t	4,944	44,500		248	60 00	14,900	59,400	D
C	E1E	MP		85	Miscellaneous Feed Screws	3	ea	3,000	9,000		33	60 00	2,000	11,000	D
C	E1E	MP		86	Flexible Wall Slag Conveyor 10HP	1	ea	158,000	158,000		800	60 00	48,000	206,000	D
C	E1E	MP		87	Flexible Wall Coke Conveyor 5HP	1	ea	137,000	137,000		683	60 00	41,000	178,000	D
C	E1E	MP		88	Slag Storage Bin (4 h)	20	t	5,000	100,000		533	60 00	32,000	132,000	D
C	E1E	MP		89	Storage Bin Slide Gate	1	ea	7,000	7,000		17	60 00	1,000	8,000	D
C	E1E	MP		90	Slag Weigh Bin 60 T	13	t	4,946	64,300		358	60 00	21,500	85,800	D
C	E1E	MP		91	Furnace Feed Screws 2HP (1Drive)	3	ea	3,000	9,000		33	60 00	2,000	11,000	D

HATCH

BRUNSWICK MINING AND SMELTING
SLAG FUMING FEASIBILITY STUDY
PROJECT 16855

BY: KIRAN JANI

DATE: 2/26/98

Cost Code	WBS	Matrix Code	Equip Type	ID	ITEM DESCRIPTION	QTY	UNIT	UNIT MATERIAL COST	TOTAL MATERIAL COST	UNIT LAB HRS	TOTAL LAB HRS	LABOUR RATE ($/HR)	TOTAL LAB COST	TOTAL COST	RISK CODE
C	E1E	MP		92	Coke Storage Bin 20T	6	I	3,167	19,000		83	60 00	5,000	24,000	D
C	E1E	MP		93	Coke Feed Screws 2HP ea	3	ea	4,000	12,000		50	60 00	3,000	15,000	D
C	E1E	MP		94	Emergency Shut Off Gates	2	ea	5,000	10,000		32	60 00	1,900	11,900	D
C	E1E	V		95	Miscellaneous Bin Load Cells & Isolators	1	ea	5,000	5,000		80	60 00	4,800	9,800	D
C	E1E	V		96	Slag Weigh Bin-Load Cells & Isolators	1	ea	5,000	5,000		80	60 00	4,800	9,800	D
C	E1E	V		97	Coke Bin-Load Cells & Isolators	1	ea	5,000	5,000		80	60 00	4,800	9,800	D
C	E1E	U		98	Process Electrics	1	Lot	50,200	50,200		607	60 00	36,400	86,600	D
C	E1E	V		99	Process Control	1	Lot	68,600	68,600		1,642	60 00	98,500	167,100	D
	E1E Total								**1,777,700**		**17,255**		**1,035,300**	**2,813,000**	
C	E1F				**SLAG AND COKE DRYING**										
C	E1F	MP		100	Baghouse Fines Screw Conveyor 1HP ea	2	ea	4,000	8,000		33	60 00	2,000	10,000	D
C	E1F	MP		101	Slag Rotary Dryer	1	ea	600,000	600,000		2,450	60 00	147,000	747,000	B
C	E1F	MP		102	Coke Rotary Dryer	1	ea	300,000	300,000		1,200	60 00	72,000	372,000	B
C	E1F	MP		103	Foundations for Dryers	140	cuyd	250	35,000		583	60 00	35,000	70,000	D
C	E1F	MP		104	Slag Dryer Combustion Air Fan incl in Dryer	1	ea								
C	E1F	MP		105	Coke Dryer Combustion Air Fan incl in Dryer	1	ea								
C	E1F	MP		106	Dry Coke Surge Bin	1	ea	5,000	5,000		33	60 00	2,000	7,000	F
C	E1F	MP		107	Dry Coke Vibrating Feeder	1	ea	15,000	15,000		50	60 00	3,000	18,000	D
C	E1F	U		108	Process Electrics	1	Lot	40,000	40,000		500	60 00	30,000	70,000	D
C	E1F	V		109	Process Control	1	Lot	20,000	20,000		1,000	60 00	60,000	80,000	D
	E1F Total								**1,023,000**		**5,850**		**351,000**	**1,374,000**	
D	E1G				**FURNACE & AUXILIARIES**										
D	E1G	C		110	Furnace Foundations	480	cuyd	250	120,000		2,000	60 00	120,000	240,000	D
D	E1G	K		111	Pressure Relief	1	Lot	350,000	350,000		5,833	60 00	350,000	700,000	F
D	E1G	N		112	DC Bus System Includes Bus, Insulators, Clamps 2(20Barsx8m) Total 320m.	16295	kg	17	272,500		2,400	60 00	144,000	416,500	D
D	E1G	NP		113	Main Subharmonic Filter 20 MVAR@30$	1	ea		600,000		1,500	60 00	90,000	690,000	D
D	E1G	NP		114	Electrode Position Control Programming	1	Lot		0		4,167	60 00	250,000	250,000	F
D	E1G	NP		115	ABB Quote DC Arc Furnace Electric's including:	1	Lot	5,180,000	5,180,000		12,950	60 00	777,000	5,957,000	B
D	E1G	NP			System Design and Interface Coordination										
D	E1G	NP			Two (2) Twin Thyristor Rectifiers										
D	E1G	NP			Two (2) Sets Flexible AC Bus										
D	E1G	NP			One (1) DC Twin Reactor										
D	E1G	NP			One (1) Rectifier Control (local)										
D	E1G	NP			One (1) DC-Metering Cabinet										
D	E1G	NP			One (1) Cooling Unit-Skid Mounted										

HATCH

BRUNSWICK MINING AND SMELTING
SLAG FUMING FEASIBILITY STUDY
PROJECT 16855

BY: KIRAN JANI

DATE: 2/26/98

Cost Code	WBS	Matrix Code	Equip Type	ID	ITEM DESCRIPTION	QTY	UNIT	UNIT MATERIAL COST	TOTAL MATERIAL COST	UNIT LAB HRS	TOTAL LAB HRS	LABOUR RATE ($/HR)	TOTAL LAB COST	TOTAL COST	RISK CODE
D	E1G	NP			One (1) Set loose Supplied Material										
D	E1G	NP			One (1) Set Technical Documentation										
D	E1G	NP			DC Busbar as per enclosed Layout										
D	E1G	NP			One H.V. Switchgear EAF										
D	E1G	NP			One 25 kV 50/56 MVA Transformer										
D	E1G	NP		116	Spare Rectificier Transformer (included in Working Capital)	1	ea								
D	E1G				**Furnace Equipment**										
D	E1G	MP		117	Roof Steel (Girders, Holddowns, Ring Beam including Electrical Insulation)	50	t	6,000	300,000	50	2,500	60.00	150,000	450,000	C
D	E1G	MP		118	Refractory (15' thk, with s.s. Hangers)	50	t	5,100	255,000	100	5,000	60.00	300,000	555,000	C
D	E1G	MP		119	Copper Roof Coolers	41	t	11,000	451,000	75	3,075	60.00	184,500	635,500	C
D	E1G	MP		120	Roof Cast Refractory Main Electrode Port	2	t	2,000	4,000	100	200	60.00	12,000	16,000	C
D	E1G	MP		121	Roof Cast Refractory Start Up Electrode Port	1.6	t	2,000	3,200	100	160	60.00	9,600	12,800	C
D	E1G	MP		122	Wall refractory (95% Mgo)	520	t	840	436,800	75	39,000	60.00	2,340,000	2,776,800	C
D	E1G	MP		123	Upper Hearth Conductive Refractory	46.2	t	3,500	161,700	100	4,620	60.00	277,200	438,900	C
D	E1G	MP		124	Upper Hearth Non Conductive Refractory	71.4	t	840	60,000	75	5,355	60.00	321,300	381,300	C
D	E1G	MP		125	Lower Hearth Conductive Refractory	19.6	t	13,300	260,700	100	1,960	60.00	117,600	378,300	C
D	E1G	MP		126	Lower Hearth Non Conductive Refractory	67.2	t	840	56,400	75	5,040	60.00	302,400	358,800	C
D	E1G	MP		127	Infill Brick	98	t	560	55,000	100	9,800	60.00	588,000	643,000	C
D	E1G	MP		128	Infill Castable	18.2	t	1,016	18,500	75	1,365	60.00	81,900	100,400	C
D	E1G	MP		129	Expansion Papers	1	Lot	18,200	18,200	600	600	60.00	36,000	54,200	C
D	E1G	MP		130	Side Shell Plate	90	t	4,200	378,000	50	4,500	60.00	270,000	648,000	C
D	E1G	MP		131	Side Shell Plate Tension Brackets	16.9	t	5,600	94,600	50	845	60.00	50,700	145,300	C
D	E1G	MP		132	Side Shell Plate Spring Tensioners	60	ea	1,400	84,000	25	1,500	60.00	90,000	174,000	C
D	E1G	MP		133	Side Shell Plate Hydraulic Tensioners	30	ea	5,600	168,000	25	750	60.00	45,000	213,000	C
D	E1G	MP		134	Bottom Shell Plate	20	t	4,200	84,000	50	1,000	60.00	60,000	144,000	C
D	E1G	MP		135	Grillage Beams	29	t	4,200	121,800	50	1,450	60.00	87,000	208,800	C
D	E1G	MP		136	Bottom Cooling Ductwork	5	t	4,900	24,500	100	500	60.00	30,000	54,500	C
D	E1G	MP		137	Bottom Cooling Fan	2	ea	24,700	49,400	350	700	60.00	42,000	91,400	C
D	E1G	MP		138	Copper Finger Cooler	430	ea	3,000	1,290,000	5	2,150	60.00	129,000	1,419,000	C
D	E1G	MP		136	Copper Lead Tapping Block	1	ea	26,700	26,700	25	25	60.00	1,500	28,200	C
D	E1G	MP		140	Copper Speiss Tapping Block	1	ea	26,700	26,700	25	25	60.00	1,500	28,200	C
D	E1G	MP		141	Copper Slag Tapping Block c/w Face Plate	2	ea	18,900	37,800	25	50	60.00	3,000	40,800	C
D	E1G	MP		142	Copper Finger Electrode	18	ea	7,000	126,000	50	900	60.00	54,000	180,000	C
D	E1G	MP		143	Furnace Cooling Water Piping (from Header to Furnace back to Tundish, not including Header or Tundish)	1	system	220,000	220,000	2,500	2,500	60.00	150,000	370,000	D
D	E1G	MP		144	Mudgun c/w Drill	2	ea	231,000	462,000	750	1,500	60.00	90,000	552,000	C

HATCH

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BY: KIRAN JANI

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Cost Code	WBS	Matrix Code	Equip Type	ID	ITEM DESCRIPTION	QTY	UNIT	UNIT MATERIAL COST	TOTAL MATERIAL COST	UNIT LAB HRS	TOTAL LAB HRS	LABOUR RATE ($/HR)	TOTAL LAB COST	TOTAL COST	RISK CODE
D	E1G	MP		145	Lead Launder	1	ea	16,800	16,800	200	200	60.00	12,000	28,800	C
D	E1G	MP		146	Iron Speiss Launder	1	ea	16,800	16,800	200	200	60.00	12,000	28,800	C
D	E1G	MP		147	W/C Copper Slag Launder	2	ea	29,400	58,800	400	800	60.00	48,000	106,800	C
D	E1G	MP		148	New Hydraulic Power Pack, Motors (2) and Pumps (2)	1	ea	280,000	280,000	1,500	1,500	60.00	90,000	370,000	C
D	E1G	MP		149	Main Electrode Hoist Cylinders	2	ea	21,000	42,000	200	400	60.00	24,000	66,000	C
D	E1G	MP		150	Hydraulic Slipping/Clamping Cylinders	2	ea	28,000	56,000	40	80	60.00	4,800	60,800	C
D	E1G	MP		151	Hydraulic Fluid (non flammable)	1,500	Gal	21	31,500	0	75	60.00	4,500	36,000	C
D	E1G	MP		152	Furnace Blocks	1	Lot	30,000	30,000		0	60.00	0	30,000	F
D	E1G				**Main Electrode Column**										C
D	E1G	MP		153	Electrode Seal Levelling Plate	1	ea	31,500	31,500	300	300	60.00	18,000	49,500	C
D	E1G	MP		154	Electrode Seal	1	ea	147,000	147,000	400	400	60.00	24,000	171,000	C
D	E1G	MP		155	Electrode Seal Packings	20	m	70	1,400	40	800	60.00	48,000	49,400	C
D	E1G	MP		156	Power Clamp, including Buss Ring and c/w Tubes, Support Ring	1	ea	336,000	336,000	1,800	1,800	60.00	108,000	444,000	C
D	E1G	MP		157	Slipping Clamp - Electrode Positioning	1	ea	100,800	100,800	750	750	60.00	45,000	145,800	C
D	E1G				**Start up Electrode**										C
D	E1G	MP		158	Start-up electrode mast and arm	1	ea	176,400	176,400	700	700	60.00	42,000	218,400	C
D	E1G	MP		159	Start-up Electrode Hoist Cylinder	1	ea	21,000	21,000	150	150	60.00	9,000	30,000	C
D	E1G			160	**Process Electric & Process Control**				0				0	0	D
D	E1G	U		161	Process Electrics	1	Lot	66,500	66,500		775	60.00	46,500	113,000	D
D	E1G	V		162	Process Control	1	Lot	715,000	715,000		7,370	60.00	442,200	1,157,200	D
	E1G Total								**13,924,000**		**142,220**		**8,533,200**	**22,457,200**	
E	E1H				**FUMING FURNACE OFF-GAS SYSTEM**										
E	E1H	K		163	Furnace off Gas Duct	1	Lot	400,000	400,000		6,667	60.00	400,000	800,000	F
E	E1H				**ISP Lead Splash Condenser & Scrubber System**										
E	E1H	C		164	Condenser (ISP) & Scrubber Foundations	260	cuyd	250	65,000		958	60.00	57,500	122,500	D
E	E1H	D		165	LCV Ducts	500	Ft	250	125,000	4.30	1,720	60.00	103,200	228,200	D
E	E1H	L		166	Valves 14"	2	ea	5,000	10,000	50	100	60.00	6,000	16,000	D
E	E1H	MP		167	Lead Splash Condenser	1	ea		388,800		0	60.00		388,800	Q
E	E1H	MP		168	Condenser Refractories	1	ea		290,400		0	60.00		290,400	Q
E	E1H	MP		169	Condenser Rotors (4 installed, 4 standby)	1	Lot		501,600		0	60.00		501,600	Q
E	E1H	MP		170	Pump Sump Dross Extractor	1	Lot		31,200		0	60.00		31,200	Q
E	E1H	MP		171	Lead Pumps (2 installed, 4 standby)	1	Lot		213,600		0	60.00		213,600	Q
E	E1H	MP		172	Lead Cooling Launder and Separation Baths	1	Lot		170,400		0	60.00		170,400	Q
E	E1H	MP		173	Refractories for Launder and Separation Baths	1	Lot		170,400		0	60.00		170,400	Q

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BY: KIRAN JANI

DATE: 2/26/98

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E	E1H	MP		174	1 Set of Immersible Coolers	1	Lot		420,000		0	60.00		420,000	Q
E	E1H	MP		175	Lead Hoist	1	Lot		7,200		0	60.00		7,200	Q
E	E1H	MP		176	Burners	1	Lot		62,400		0	60.00		62,400	Q
E	E1H	MP		177	Combustion Air Fans	1	Lot		31,200		0	60.00		31,200	Q
E	E1H	MP		178	Duct (to Gas Washing Tower)	1	Lot		14,400		0	60.00		14,400	Q
E	E1H	MP		179	Gas Washing Tower	1	Lot		57,600		0	60.00		57,600	Q
E	E1H	MP		180	Ventun Scrubber, Ducting, Separator & Fan	1	Lot		86,400		0	60.00		86,400	Q
E	E1H	MP		181	Agitated Seal Tank & Pump	1	Lot		38,400		0	60.00		38,400	Q
E	E1H	MP		182	Rotor Stands	1	Lot		14,400		0	60.00		14,400	Q
E	E1H	MP		183	Lead Pump Stands	1	Lot		9,600		0	60.00		9,600	Q
E	E1H	MP		184	Engineering (included in EPCM Cost)	1	Lot								
E	E1H	U		185	Electrics	1	Lot		513,600		0	60.00		513,600	Q
E	E1H	V		186	Instruments	1	Lot		326,400		0	60.00		326,400	Q
	E1H Total								**3,948,000**		**9,445**		**566,700**	**4,514,700**	
G	E1I				**FUME & DUST CONTROL & COMBUSTION CHAMBER**										
G	E1I	MP		187	LCV Combustion Chamber & LCV Combustion Air Fan	1	Lot	125,000	125,000		2,083	60.00	125,000	250,000	F
G	E1I	Q		188	Baghouse System c/w EQPT Foundation, Ind Fan, Ducts, Baghouse Duct Support, Stack 200,000 CFM	1	Lot	4,400,000	4,400,000		26,667	60.00	1,600,000	6,000,000	C
G	E1I	V		189	CO Gas Monitoring & Control	1	Lot	80,000	80,000		333	60.00	20,000	100,000	F
	E1I Total								**4,605,000**		**29,083**		**1,745,000**	**6,350,000**	
E	E1J				**ZINC CASTING (provided by ISP)**										
E	E1J	C		190	Casting Foundations	100	cuyd	250	25,000		417	60.00	25,000	50,000	D
E	E1J	L		191	Strapping System	1	Lot	280,000	280,000		833	60.00	50,000	330,000	F
E	E1J	L		192	2" CS Sch 40 Pipe	180	ft	22	3,900		65	60.00	3,900	7,800	D
E	E1J	L		193	3" CS Sch 40 Pipe	10	ft	60	600		8	60.00	500	1,100	D
E	E1J	L		194	6" CS Sch 40 Pipe	25	ft	96	2,400		40	60.00	2,400	4,800	D
E	E1J	L		195	8" CS Sch 40 Pipe	30	ft	120	3,600		60	60.00	3,600	7,200	D
E	E1J	L		196	10" CS Sch 40 Pipe	3	ft	167	500		8	60.00	500	1,000	D
E	E1J	L		197	Misc. Valves(for all above Pipe)	1	Lot	5,500	5,500		92	60.00	5,500	11,000	D
E	E1J	L		198	Zinc Cooling Spray System c/w Tank Pump	1	Lot	50,000	50,000		833	60.00	50,000	100,000	F
E	E1J	MP		199	Direct Slab Caster	1	ea	388,800	388,800		0	60.00	0	388,800	Q
E	E1J	MP		200	Stacking System	1	ea	523,200	523,200		0	60.00	0	523,200	Q
E	E1J	MP		201	Shipping/Loading Truck	1	ea	50,000	50,000		0	60.00		50,000	D
E	E1J	V		202	Process Electr. Control (in Condenser E1H)	1	Lot								

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	E1J Total								**1,333,500**		**2,357**		**141,400**	**1,474,900**	
G	E1K				**BLUE POWDER RECYCLE**										
G	E1K	C		203	Concrete for Clarifier	1	Lot	12,000	12,000		208	60 00	12,500	24,500	C
G	E1K	D		204	Clarifier Tank Shell	1	Lot	42,000	42,000		208	60 00	12,500	54,500	C
G	E1K	D		205	Clarifier Sludge Tank	1	ea	7,500	7,500		33	60 00	2,000	9,500	C
G	E1K	L		206	Clarifier Sludge Pumps	2	ea	17,000	34,000		167	60 00	10,000	44,000	C
G	E1K	L		207	1" CS Sch 40 Pipe	290	ft	19	5,400		90	60 00	5,400	10,800	D
G	E1K	L		208	4" CS Sch L40 Pipe	720	ft	68	49,300		822	60 00	49,300	98,600	D
G	E1K	L		209	6" CS Sch L40 Pipe	28	ft	96	2,700		45	60 00	2,700	5,400	D
G	E1K	L		210	Misc. Valves	1	Lot	28,700	28,700		478	60 00	28,700	57,400	D
G	E1K	MP		211	Clarifier 20'ID Mechanism	1	ea	67,000	67,000		125	60 00	7,500	74,500	C
G	E1K	MP		212	Scrubber Recycle Cooler & Pumps & Tank	1	Lot	50,000	50,000		833	60 00	50,000	100,000	F
G	E1K	U		213	Process Electrics	1	Lot	20,000	20,000		283	60 00	17,000	37,000	D
G	E1K	V		214	Process Controls	1	Lot	87,000	87,000		1,133	60 00	68,000	155,000	D
	E1K Total								**405,600**		**4,427**		**265,600**	**671,200**	
D	E1L				**SLAG GRANULATION**										
D	E1L	C		215	Concrete	40	cuyd	250	10,000		167	60 00	10,000	20,000	F
D	E1L	L		216	Granulation Pump & Local Piping	2	Lot	50,000	100,000		1,667	60 00	100,000	200,000	F
D	E1L	L		217	Sluiceway (Granulation)	1	ea	20,000	20,000		250	60 00	15,000	35,000	C
D	E1L	L		218	Granulation Transfer Sump	1	ea	25,000	25,000		125	60 00	7,500	32,500	C
D	E1L	L		219	Emergency Head Tank c/w Supports & Piping	1	Lot	160,000	160,000		1,270	60 00	76,200	236,200	F
D	E1L	U		220	Process Electrics	1	Lot	18,000	18,000		183	60 00	11,000	29,000	D
D	E1L	V		221	Process Control	1	Lot	12,000	12,000		150	60 00	9,000	21,000	D
	E1L Total								**345,000**		**3,812**		**228,700**	**573,700**	
I	F1A				**MISCELLANEOUS PURCHASES**										
I	F1A	MP		222	Forklifts	1	ea	35,000	35,000		0	60 00	0	35,000	D
I	F1A	MP		223	Dump Slag Dump Truck 5 T	1	ea	100,000	100,000		0	60 00	0	100,000	D
I	F1A	MP		224	Moulds, Boxes etc	1	Lot	100,000	100,000		0	60 00	0	100,000	F
	F1A Total								**235,000**		**0**		**0**	**235,000**	
	Direct Cost Total								**37,156,000**		**287,422**		**17,293,300**	**54,449,300**	
J	Z1A				**INDIRECT COST**										

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J	Z1A	Z		225	Temporary Services (1.5% of Direct Cost)									817,000	D
J	Z2A	Z		226	Spares (included in Working Capital)										
J	Z3A	Z		227	Vendor Assistance+Commissioning 3% of Direct Cost									1,633,500	D
J	Z4A	Z		228	Freight 3% of Mechanical & Electrical Eqpt Cost									900,000	D
J	Z5A	Z		229	EPCM, including ISP Engineering (20% of Total Direct Cost)									10,890,000	D
J	Z6A	Z			**Owners Cost**										
J	Z6A	Z		230	Project Team (10 ManYears)									1,000,000	D
J	Z6A	Z		231	Insurance (0.5% of Direct Cost)									272,200	D
J	Z6A	Z		232	Permitting									100,000	D
J	Z6A	Z		233	Duties & Taxes									0	
J	Z6A	Z		234	Training (20 people x 3 mths)									500,000	D
J	Z6A	MP		235	KnowHow Fees-ISP									500,000	X
J	Z6A	Z		236	Licence-Mintek									1,000,000	X
J	Z6A	Z		237	Royalties and Licence for Furnace Technology (Copper Coolers, Wall Hold Downs and Bottom Electrode)-Hatch									1,000,000	X
Indirect Cost Total														**18,612,700**	
Total Cost Before Contingency														**73,062,000**	
K	Z8A	Z			**Contingency**									**19,938,000**	
Total Project Capital Cost														**93,000,000**	

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PLANT COST ESTIMATE - DISCIPLINE MATRIX

SYSTEM	A-SITE PREP (A)	C-CONCRETE (C)	D-STRUCT STEEL (D)	E-CLADDING (E)	F-ARCH FINISHES (F)	G-ELECT SERVICES (G)	J-MECH PROC EQUIP (MP)	P- CONTROL ROOMS COMPLETE	Q- MULTIDISCIPLINE (Q)	Q-ENVIRON (K)	R-PIPING (L)	S-ELECT HIGH VOLT (N)	S-ELECT HIGH VOLT (NP)	T-ELECT PROCESS (U)	U-PROCESS CTRL (V)	Z-INDIRECTS (Z)	Grand Total
A1A Demolition	20,000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	20,000
A1B General Site Preparation	100,000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	100,000
A1C Roads	10,000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10,000
A1D Relocation	0	0	0	0	0	0	0	0	500,000	0	0	0	0	0	0	0	500,000
A1F Drainage	20,000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	20,000
C1D Cooling Water	0	280,000	0	0	0	0	506,000	60,000	0	0	594,600	0	0	110,000	154,000	0	1,704,600
C1E Sea Water	0	0	329,900	0	0	0	0	0	0	0	363,900	0	0	0	0	0	693,800
C1F Fire Protection Water	0	0	0	0	0	0	0	0	0	0	20,000	0	0	0	0	0	20,000
C3A Instrument Air	0	0	0	0	0	0	0	0	0	0	25,000	0	0	0	0	0	25,000
C3B Compressed Air	0	0	0	0	0	0	150,000	0	0	0	0	0	0	0	0	0	150,000
C4A Nitrogen	0	0	0	0	0	0	0	0	0	0	50,000	0	0	0	0	0	50,000
D1A 138 KV Switchgear	0	0	0	0	0	0	0	0	0	0	0	0	3,372,000	0	0	0	3,372,000
D2A 25 KV Switchgear	0	0	0	0	0	0	0	0	0	0	0	285,000	0	0	0	0	285,000
D3A 4160 KV Switchgear	0	0	0	0	0	0	0	0	0	0	0	0	348,000	0	0	0	348,000
D3A 4160 KV Switchgear	0	0	0	0	0	0	0	0	0	0	0	260,000	433,000	0	0	0	693,000
E1A Building	0	843,500	2,333,700	677,900	90,000	180,000	539,000	0	0	250,000	0	0	0	0	0	0	4,714,100
E1B Control, Electrical Rooms	0	0	0	0	0	0	0	677,100	0	0	0	0	0	0	0	0	677,100
E1C Cranes	0	0	0	0	0	0	550,000	0	0	0	0	0	0	53,000	0	0	603,000
E1E Material Receipt and Storage	0	1,085,500	71,000	87,100	0	0	1,288,300	0	0	0	0	0	0	86,600	196,500	0	2,813,000
E1F Slag and Coke Drying	0	0	0	0	0	0	1,224,000	0	0	0	0	0	0	70,000	80,000	0	1,374,000
E1G Furnace and Auxilliaries	0	240,000	0	0	0	0	12,933,500	0	0	700,000	0	416,500	6,897,000	113,000	1,157,200	0	22,457,200
E1H Off Gas Handling System	0	122,500	228,200	0	0	0	2,508,000	0	0	800,000	16,000	0	0	513,600	326,400	0	4,514,700
E1I Off Gas Handling System	0	0	0	0	0	0	250,000	0	6,000,000	0	0	0	0	0	100,000	0	6,350,000
E1J Off Gas Handling System	0	50,000	0	0	0	0	962,000	0	0	0	462,900	0	0	0	0	0	1,474,900
E1K Off Gas Handling System	0	24,500	64,000	0	0	0	174,500	0	0	0	216,200	0	0	37,000	155,000	0	671,200
E1L Discard Slag Granulation	0	20,000	0	0	0	0	0	0	0	0	503,700	0	0	29,000	21,000	0	573,700
F1A Mobile Equipment	0	0	0	0	0	0	235,000	0	0	0	0	0	0	0	0	0	235,000
Z1A Temporary Facilities	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	817,000	817,000
Z2A Spares	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Z3A Vendor Assistance	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1,633,500	1,633,500
Z4A Freight	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	900,000	900,000
Z5A EPCM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10,890,000	10,890,000
Z8A Commissioning/Start-up	0	0	0	0	0	0	500,000	0	0	0	0	0	0	0	0	3,872,200	4,372,200
Z8A Contingency	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	19,938,000	19,938,000
Grand Total	150,000	2,466,000	3,026,800	765,000	90,000	180,000	21,818,300	737,100	6,500,000	1,750,000	2,252,300	961,500	11,050,000	1,012,200	2,190,100	38,050,700	93,000,000

8.1 Risk Analysis

Financial Risk

To determine a project contingency associated with the scope of the estimate a Monte Carlo Financial Simulation model was used.

For each major element of the estimate a range is assigned based on the type of estimate developed.

The plus/minus estimates represent a range of costs that would be expected under normal circumstances. These ranges are intended to reflect variations in final cost due to factors such as unforeseen circumstances, competitive market conditions, availability of resources and general design progress.

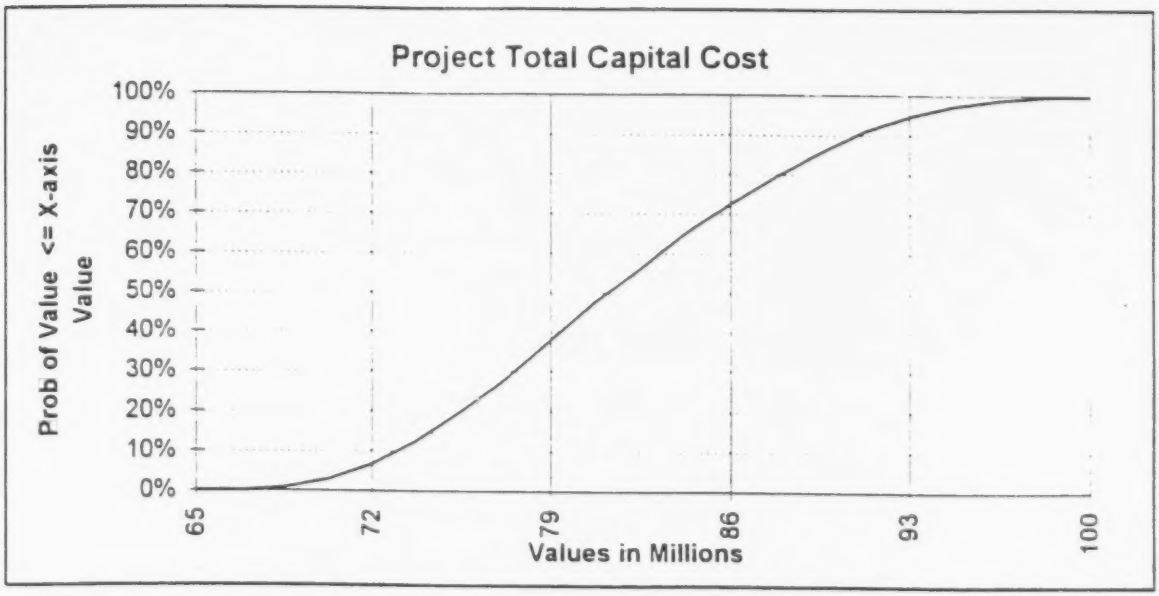
The scope of this analysis is limited to that contained within the scope of the estimate.

The analysis of the capital cost estimate results in the risk curve.

The analysis suggests that in order to achieve an 95 confidence level, the project should anticipate a final cost of around 93 million. This includes a 19.9 million dollar contingency added to the base estimate in order to achieve the desired project confidence level.

Risk Summary Graph

Estimate Category	COST CDN $1000	Probability Range +	-
B Fax Quotation	7,346	20.00%	-5.00%
C Factored Estimate	18,861	25.00%	-10.00%
D Database	34,782	35.00%	-10.00%
F Allowance	5,313	50.00%	-25.00%
Q Packaged Equipment	4,260	20.00%	0.00%
X Other Source	2,500	20.00%	-20.00%
TOTAL COST	73,062		



9. UTILITY REQUIREMENTS

Table 9-1: Fuming Furnace and Total Plant Energy Requirements

	kCal/hr	MW
Fuming Furnace		
Sensible Heat	13,881,039	16.1
Heat of Fusion	3,851,078	4.5
Reduction Energy	8,257,277	9.6
Heat Losses	3,441,600	4.0
Electrical Losses	898,258	1.1
TOTAL Furnace Energy Required	30,329,252	35.3
Balance of Plant		2.1
TOTAL PLANT ENERGY REQUIRED		**37.4**

Table 9-2: Utilities List

Item	Non-Contact Cooling Water	Raw Water	Compressed Air	Nitrogen Gas	Fuel Oil	Water Treatment Discharge
Coke Dryer						
Slag Dryer *					100 t/y	
Fuming Furnace	1100 m^3/hr			400 m^3/hr		
Slag Granulation						
ISP Lead-Splash Condenser System	102 m^3/hr				85 t/y	
Scrubber Circuit Cooler	38 m^3/hr					
Cooling Tower Blowdown						12 m^3/hr
Cooling Tower Make-up		30 m^3/hr				
Clarifier Underflow						1 m^3/hr
Scrubber Circuit Bleed **						--
Scrubber Circuit Make-up		1 m^3/hr				
Zn Casting (6 hrs casting per day)		120 m^3/d	180 m^3/hr		120 t/y	100 m^3/d
Alloy Ladle Spray Coolers		12 m^3/d				12 m^3/d
Miscellaneous Uses			120 m^3/hr	200 m^3/hr		
TOTAL	**1240 m^3/hr**	**1000 m^3/d**	**300 m^3/hr**	**600 m^3/hr**	**305 t/y**	**425 m^3/d**

* assumes fuel oil needed for 5% of dryer heating requirement

** included in clarifier underflow to existing sinter plant clarifier

Table 9-3: Estimated Heat Losses / Cooling Water

		Cooling Water System			
	Expected Average Heat Removal (kW)	# of circuits	Flow/circuit (l/s)	Total Flow (l/s)	Assumptions/ Comments
Slag Zone Copper Finger Coolers	1,100	43	3	129	430 fingers, 30 kW/m^2 slag zone heat flux.
Tapping Modules	100	4 4	2.5 0.7	13	2 slag blocks c/w inserts 1 lead, 1 speiss block c/w inserts
FCE roof	1,000	30	3	90	Approx. 150 plate coolers, 10 kW/m^2
Upper sidewalls	1,200	-----	-----	-----	➢ 0 kw/m^2 ➢ 3.5 m free board height
Lower sidewalls	100	-----	-----	-----	1 kW/M^2
FCE bottom	500	-----	-----	-----	5 kW/M^2, forced air
TOTALS	4,000 Kw			232 L/S	

Notes:

- Not including sensible heat loss to hot metal / slag / off-gas.
- Heat loss from furnace to off-gas duct and pressure relief device (when not open) is just radiation through the ports in roof. Losses are included in roof loss.
  - The heat emanating from off-gas duct is by virtue of having the hot gas inside duct, i.e., loss from furnace has already been counted in sensible heat.
    Duct is refractory lined and has no load on cooling system.
- Heat losses to electrical system are not included in the above summary.
- Furnace size 10 m I.D, 11.2 m O.D.

APPENDIX

October 29, 1997

BRUNSWICK SMELTING
SLAG FUMING OPTIONS

DISTRIBUTION:

P. Hancock, Brunswick
R. Nutten, Brunswick
D. Berkley
A. Matyas
L. Hussain
V. Revankar
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SLAG FUMING OPTIONS

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If you disagree with any information contained herein, please advise immediately

1. INTRODUCTION

Heat and Material Balances have been performed and a schematic process flowsheet developed for a slag fuming facility at the Belledune Smelter. The spreadsheet model which generated the balances will be the basis for equipment signing and selection. The balances have been used in this report to help evaluate options for slag fuming. These calculations are based on a slag feed composition provided by P. Hancock of Brunswick (Option 1B) and information provided by Mintek reports. A summary of the assumptions made in the process design basis is provided (page 2) of attached documentation.

The flowsheet has been developed for the case of feeding molten blast furnace slag to a Premelter along with cold dump slag The
combined slag is heated to 1250°C and fed to the fuming furnace where coke is added and the fuming process occurs.

One of the objectives of this feasibility study was to determine the need for and efficiency of a Premelter.

The Premelter provides a buffer between the blast furnace and fuming furnace leading to steadier operation and gas flow to the condensers. However, it increases capital and energy costs as well as the number of molten slag handling and transfer operations, which complicates plant location and layout.

The study has been expanded to include the option of feeding cold slag only, which requires additional energy for heating and melting slag, but minimises or eliminates molten slag handling and transfer.

2. SUMMARY OF OPTIONS

Five options have been considered:

2.1 Case 1 - All Slag (Cold) to Premelter

Both blast furnace and dump slag are fed cold to the Premelter. Molten slag from the blast furnace is granulated, dewatered and dried. The only molten slag transfer is between the Premelter and fuming furnace, by gravity.

2.2 Case 2 - All slag (Cold) to Fuming Furnace

Both Blast furnace slag and Dump slag are fed cold directly to the fuming furnace. Molten slag from the blast furnace is granulated, dewatered and dried. There is no molten slag transfer

2.3 Case 3 - Blast Furnace Slag (Hot) to Premelter, Dump Slag (Cold) to Premelter

Blast furnace slag is transported in ladles from the blast furnace to the Premelter. Cold slag is fed to the Premelter. Molten slag is transferred by gravity between the furnaces.

2.4 Case 4 - Blast Furnace Slag (Hot) and Dump Slag (Cold) to Fuming Furnace

Blast furnace slag is transported in ladles from the blast furnace directly to the fuming furnace. Dump slag is fed directly to the fuming furnace.

2.5 Case 5 - Blast Furnace Slag (Hot) to Premelter, Dump Slag (Cold) to Fuming Furnace

Blast furnace slag is transported in ladles from the blast furnace to the Premelter. Molten slag is transferred by gravity between the furnaces. Dump slag is fed directly to the fuming furnace.

3. DISCUSSION

A comparison of options with molten slag feed (Cases 3, 4, 5) shows that the Premelter can be justified by its operational advantages. These include:

a) Providing a buffer between the blast furnace and fuming furnace to allow for upsets or shutdown of the fuming furnace

b) The ability to melt or remelt miscellaneous materials such as ladle skulls without affecting fuming furnace operation.

c) Minimum disruption and maximum stability of fuming furnace operation leading to best performance of the zinc condenser.

For a first facility it appears risky to eliminate the Premelter with molten slag feed and therefore, Case 4, would not be recommended.

A comparison of Cases 3 and 5 shows that Case 5 with both molten slag and solid feed to the fuming furance may be more difficult to operate than Case 3, with dump slag fed only to the fuming furnace in Case 5. It would be simple, however, to provide for dump slag feed to both furnaces to allow for the 0.8 MW electric saving that would result if Case 5 resulted in a smooth operation.

A comparison of options with all cold slag feed (Case 1 and 2) shows that the Premelter not only results in higher operating and capital costs, but is not as flexible or easy to operate. This

is because solid slag feed already separates the operation of the blast furnace from the fuming furnace. With cold slag feed, there is no justification for a Premelter.

A comparisons of Cases 2 and 3, the most likely cold and hot slag options, shows the following:

a) Case 2 has a 4.7 MW greater electrical energy requirement. At 5 cents/kWhr for power and 1 cent/kWhr for electrode consumption and 7140 hrs/yr operation, the extra cost would be approximately $2MM/yr.

b) The capital cost for Case 2 would be considerably lower than Case 3. The elimination of the Premelter, the slag ladles, ladle transfer cars, cranes for handling the ladles, and a very expensive fume containment system including a "Tunnel" and baghouse more than compensates for the extra slag granulation, dewatering and drying operation that will be required.

c) Case 2 will allow the fuming facility to be located at the most convenient location without worrying about proximity to the blast furnace. The facility can be located where the least disruption of existing facilities occurs. Case 3 requires close proximity to the blast furnace and will require modification and/or relocation of existing facilities to accommodate.

d) Operation and Control - Solid feeding should be controllable and provide for steady operation, more reliably than molten slag feed. There may be some dust carryover to the condenser, however, when feeding cold slag. The operation will be totally independent of the blast furnace, permitting operation when the blast furnace is shut down.

e) Maintenance - elimination of molten slag handling and transfer will reduce maintenance requirements.

f) Fuming Rate - tests have shown high fuming rates at high power densities with cold slag feed. More information is needed before comparison of furnace size for hot vs. cold slag feed.

Table 3-1: Comparison of Options

Issue	Case 1	Case 2	Case 3	Case 4	Case 5
Capital Cost	Lower than 3	Lowest	Base Case	Lower than 3	Same as 3
Electric Energy Requirement (MW)	36.7	33.3	28.6	25.2	27.8
Flexibility in Plant Location	High	Very High	Low	Low	Low
Operation & Control Difficulties	Moderate	Low	Moderate	High	Higher than 3
Separation of Blast Furnace from Fuming Operation	Total	Total	Partial	None	Partial
Maintenance	Low	Lowest	High	Moderate	High

4. SUMMARY

In summary, there are many advantages of cold slag versus molten slag feed. This is particularly true because of the need to retrofit the facility into an existing operation.

The higher energy cost associated with cold slag feed must be justified economically before a decision to proceed in that direction is made.

George Sperling

GS.bmc
Attachment(s)

1. BASIS OF CAPITAL COST ESTIMATE

The total estimated cost of the Brunswick Mining & Smelting - Slag Fuming feasibility Study is estimated as follows: -

1.1 Cost Structure

The estimate of the total installed cast of the facilities is presented as Direct and Indirect costs plus contingency.

The **Direct Costs** cover all material and labour costs related to the complete installation of the facility.

The **Indirect Costs** include

- Temporary Facilities
- Vendor Assistance and Commissioning
- Freight
- EPCM
- Owner's Cost
  - Project Team
  - Insurance
  - Permitting
    - Training
    - License
  - Royalty Fees

Budget quotes:

- ABB Rectifier
- Rotary Dryers
- Cooling Tower

Structured Estimates

Factored estimates are derived from vendor quotes which do not exactly represent the equipment which is needed. These quotes are modified based on Hatch experience to estimate the needed equipment.

Condenser

Turnkey Price includes supply and install of ISP equipment.

Current Data Base

Current data base estimates (mostly all civil, mechanical) were derived from Hatch in-house data.

These estimates can be quantity take-offs used with Foundations, Structural Steel, Piping, Electrical, Process Control mining or they can be vendor quotes which cannot be categorised as budget quotes or factored estimate.

1.2 Allowance

An allowance is an allotment of funds for a piece of equipment. Another cost item where an outside factor does not allow for more accurate estimate.

1.3 Labour Rate

A composite construction labour rate of $60/hour has been used. This rate includes base rate, burden, workman's compensation, contractor's overhead, contractor's profit and an allowance for small tools and consumables.

1.4 Prices

All prices are expressed in Canadian dollars. Exchange rate for 1 US = 1.4 CDN and 1£ = 2.40 CDN.

1.5 Working Hours

The normal working schedule is eight (8) hours a day for five (5) days a week, with interruption during Statutory Holidays. No allowance for overtime has been included.

2. ESTIMATE STRUCTURE

2.1 General

The capital cost estimate will be presented at **two different levels** (in order of increased detail).

- An overall **Project Cost Matrix**
- Estimate details by **trade** or **discipline**

Each line item on the detail estimate will correspond to a scope module identified by the Work Breakdown Structure.

An overall Project cost matrix would cover the cost of each area and broken by each account code.

- The account codes (matrix code category) corresponding to a trade or discipline and identifies where the cost is to appear in the summary matrix.
- The risk code identifies the source of information which is then used in the capital cost details as well as for future risk analysis study.

2.2 Work Breakdown Structure (WBS)

A WBS is a Project oriented hierarchy of geographical work areas that defines and graphically displays the total work to be accomplished by discipline to achieve the final objectives of a project.

Main Project Areas

Area A General Site Facilities
Area B Service Facilities
Area C Piping Utilities
Area D Electrical Utilities
Area E Facilities
Area F Mobile Equipment
Area Z Indirect

The WBS contains the breakdown by Area, Sub-area and System

Area A General Site Facilities

A1 Site Preparation
- A1A Demolition
- A1B General Site Preparation
- A1C Roads, Paving
- A1D Relocation
- A1E Railway Tracks
- A1F Drainage

Area B Service Facilities

No separate facilities are planned at this stage

Area C Piping Utilities

C1 Water Systems
- C1A Raw Water
- C1B Process Water
- C1C Storm Water
- C1D Cooling Water
- C1E Sea Water
- C1F Fire Protection Water

C2 Gas System
- C2A Recovered Process Off-Gas
- C2B No. 2 Fuel Oil

C3 Air
- C3A Instrument Air
- C3B Compressed Air

C4 Additional Air Requirements
- C4A Nitrogen

C5 Waste Disposal
- C51 Process Drainage

Area D Electrical Utilities

D1 4160 KV Switchgear
D2 25 KV Switchgear

Area E Facilities

E1 Main Process Building Requirements
- E1A Building
- E1B Control, Electrical Rooms
- E1C Cranes
- E1D Slag Reclaim
- E1E Material Receipt and Storage
- E1F Slag and Coke Drying
- E1G Furnace and Auxiliaries
- E1H Off Gas Handling System
- E1I Dust and Fumes Control
- E1J Zinc Casting and Storage
- E1K Dross, Blue Powder Recycle
- E1L Discard Slag Granulation
- E1M Plant Hygiene

Area F Mobile Equipment

F1 Mobile Equipment

Area Z Indirect

Z1 Temporary Facilities
Z2 Insurance
Z3 EPCM
Z4 Commissioning/Start-up
Z5 Duties and Other Allowances
Z6 Contingency
Z7 Owners Cost

2.3 Account Codes (Matrix Code)

Description	Account Code
Site work	A
Piling	B
Concrete	C
Structural Steel	D
Roofing and Cladding	E
Architectural	F
Building Electrical Service	G
HVAC	H
Pre-Purchased HVAC Equipment	HP
Control Rooms Complete	J
Environmental	K
Pre-Purchased Environmental Equipment	KP
Process Piping / Tuyauterie	L
Pre-Purchased piping equipment	LP
Mechanical Equipment	M
Pre-Purchased Mechanical Equipment	MP
High Voltage Equipment	N
Pre-Purchased High Voltage Equipment	NP
Piping Services	P
Multidiscipline	Q
Process Electrics	U
Pre-Purchased Process Electrics Equipment	UP
Process Control & Instrumentation	V
Pre-Purchased Process Control and Instrumentation	VP
Indirects	Z

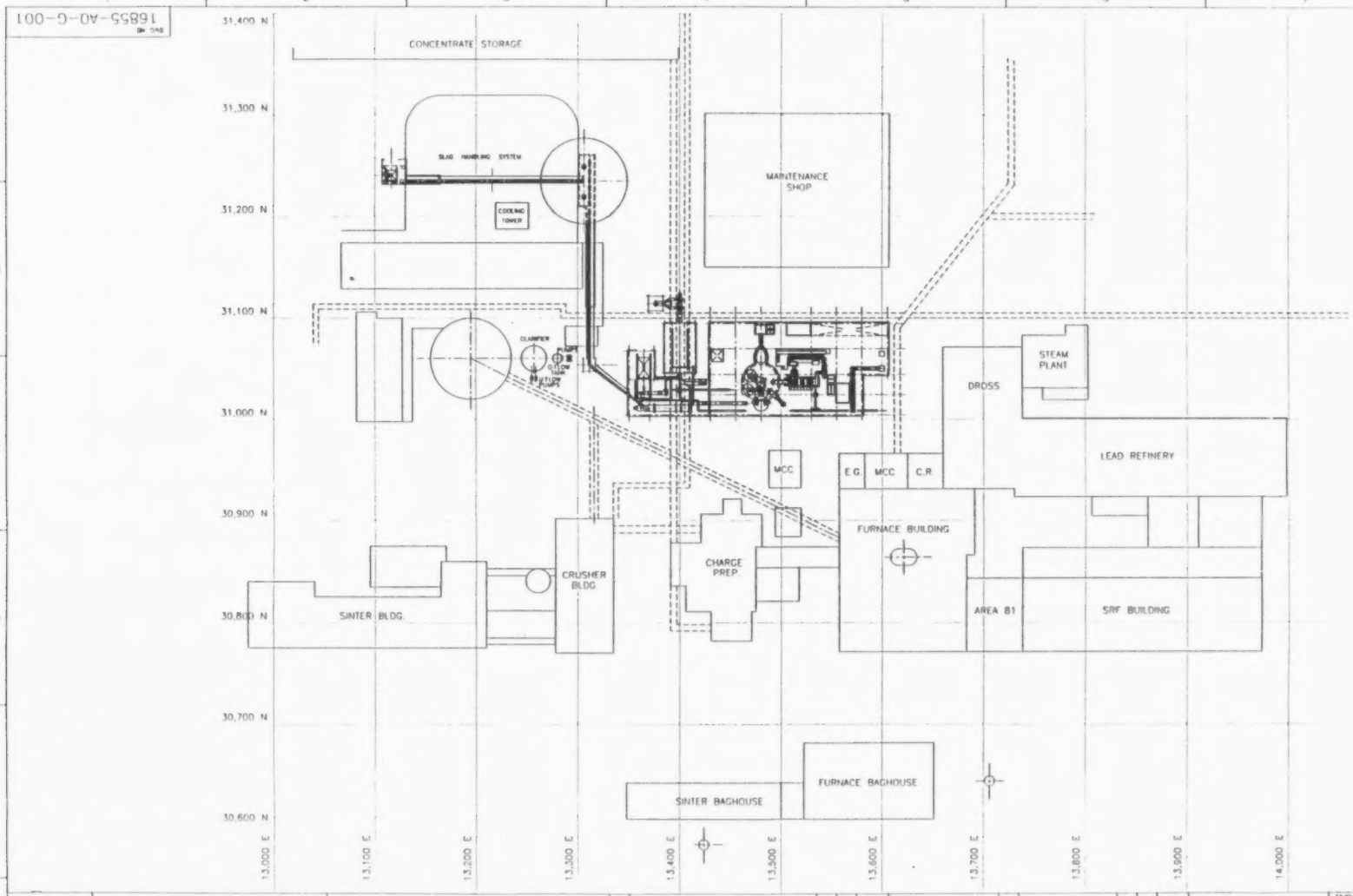
2.4 Sources of Information

Capital costs were obtained from a number of sources as shown in detail estimate and each source having a different degree of accuracy.

Source	Risk Code
1) Firm Price	A
2) Budget Quote	B
3) Factored Estimate	C
4) Current Hatch Data Base	D
5) Order of Magnitude	E
6) Allowance	F
7) Other Sources	G

3. CAPITAL COST EXCLUSIONS

- Spares
- Project Financing & Costs
- Interest During Construction
- Escalation
- Schedule Delays and associated costs such as those caused by:
  - unidentified ground conditions
  - labour disputes
  - permit applications
- Working Capital including First Fill
- Additional Raw Material
- Unloading and Handling
- Process Risk Contingency (provision of money to cover uncertainties in a new process)



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NO | DESCRIPTION | BY | APP'D | DATE

ISSUE AUTHORIZATION

REV | COST ESTIMATE | ISSUE FOR | AUTH BY | DATE

HATCH

DESIGNED BY RJJ | DRAWN BY RJJ
DATE 09/26/97 | DATE 09/26/97
CHECKED BY | DISCIP ENGR
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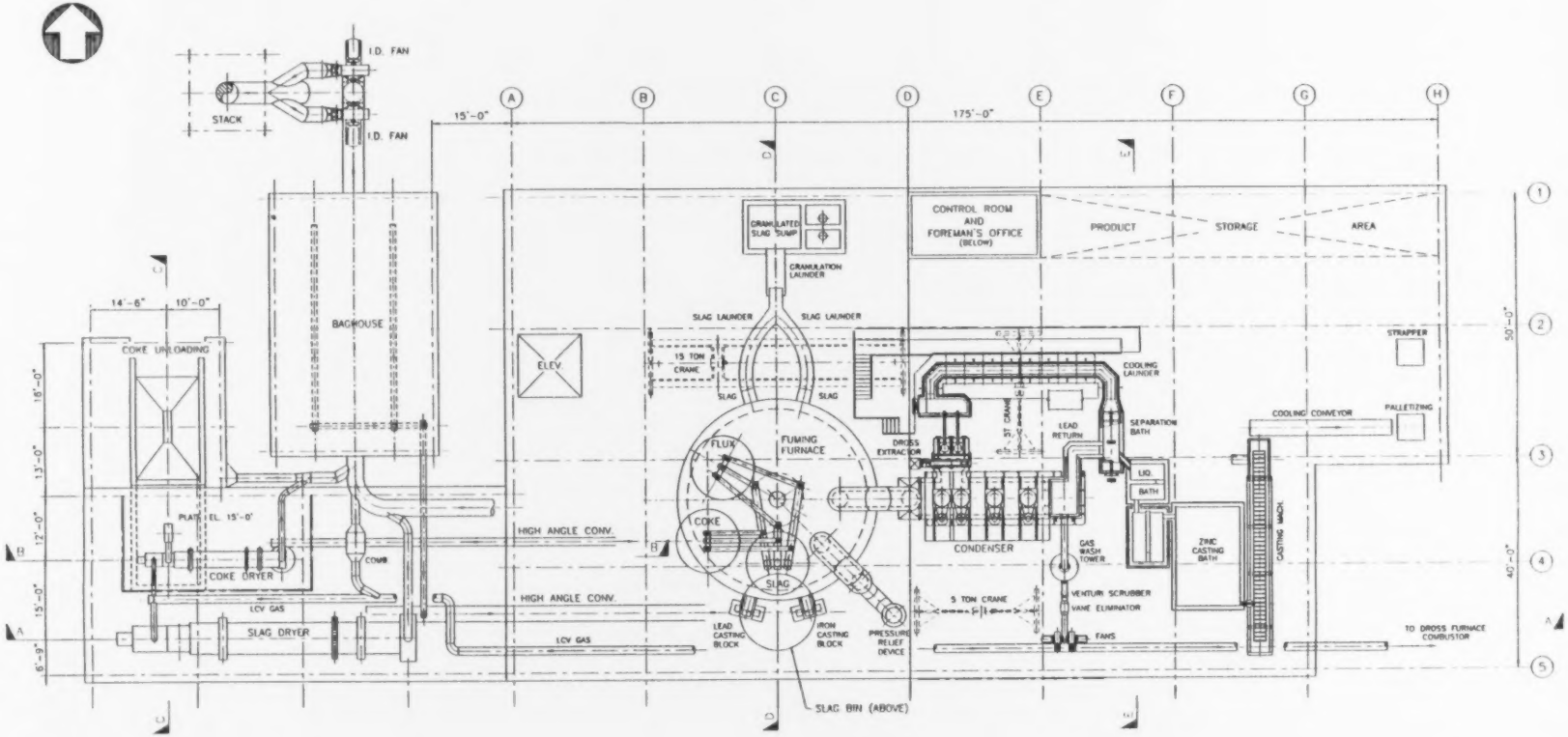
BLAST FURNACE SLAG FUMING FE

GENERAL ARRANGEM
PLANT LAYOUT

SCALE 1"=50' (SEE NOTES) | DWG NO 16855-A0



PLAN

0 8' 16' 24'

SCALE 3/32"=1'-0"

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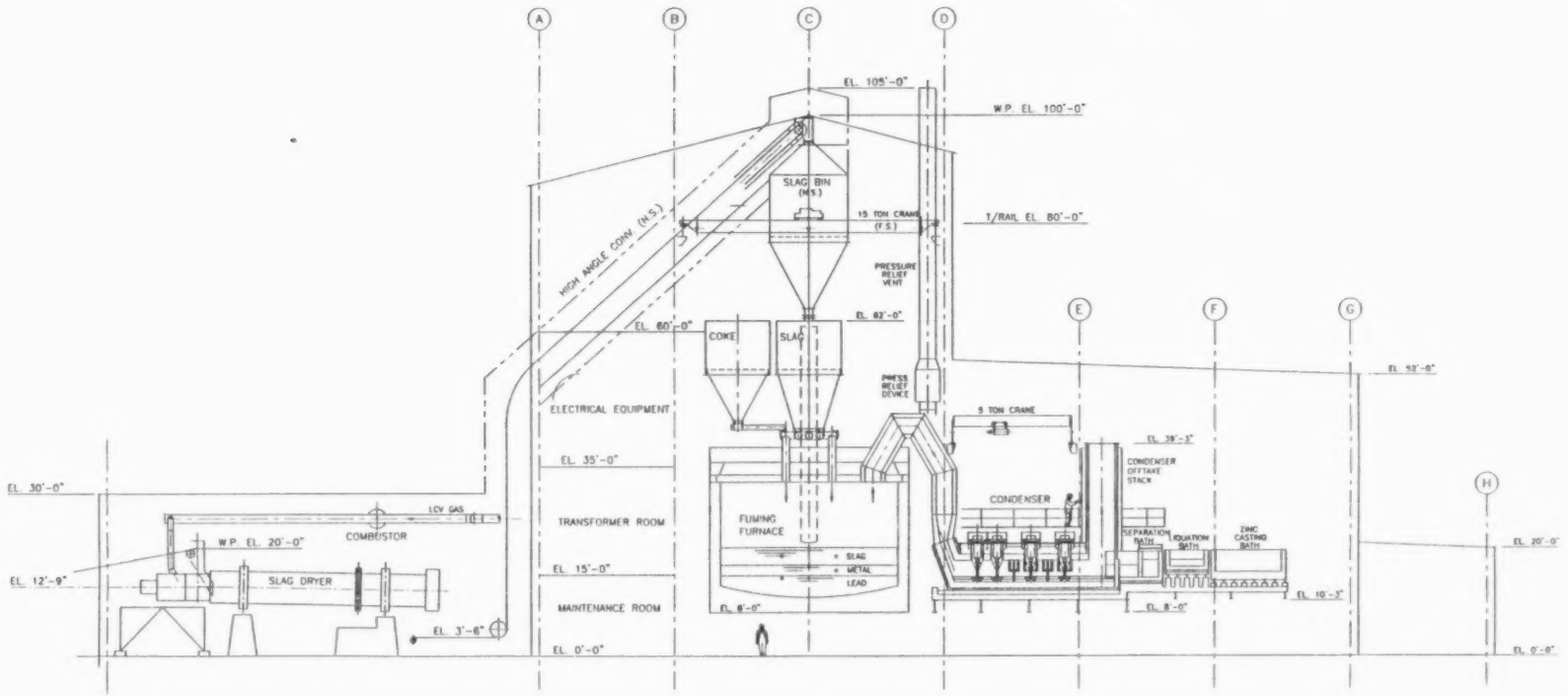

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CHECKED BY — DETAILED BY

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PROJ. MGR.

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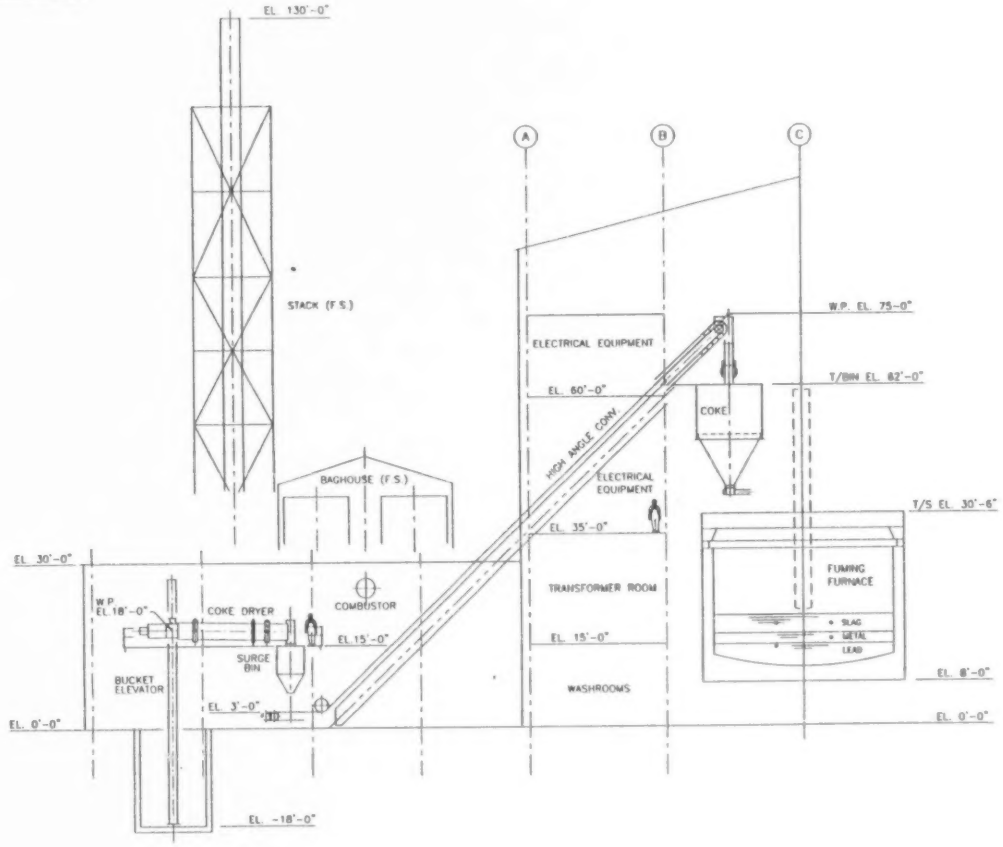

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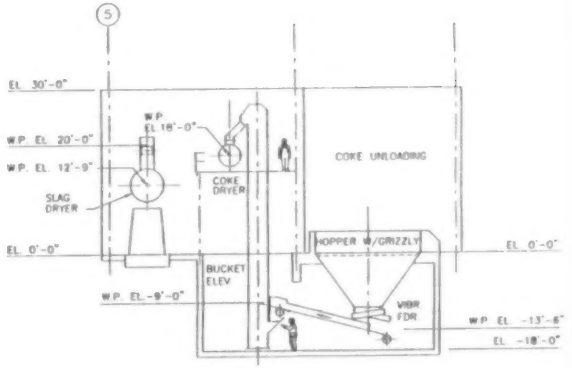

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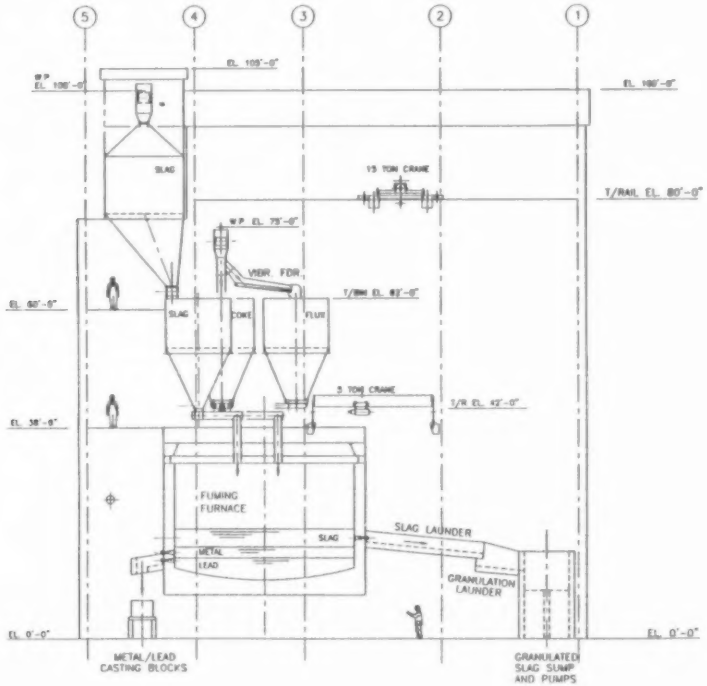

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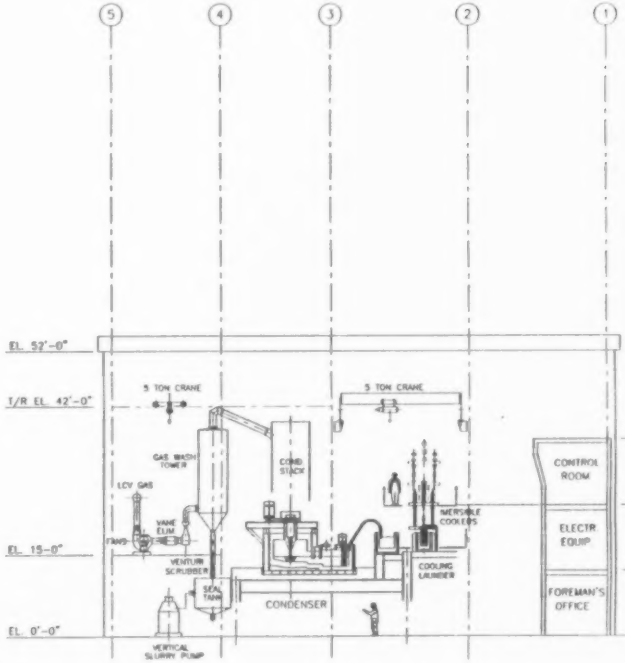

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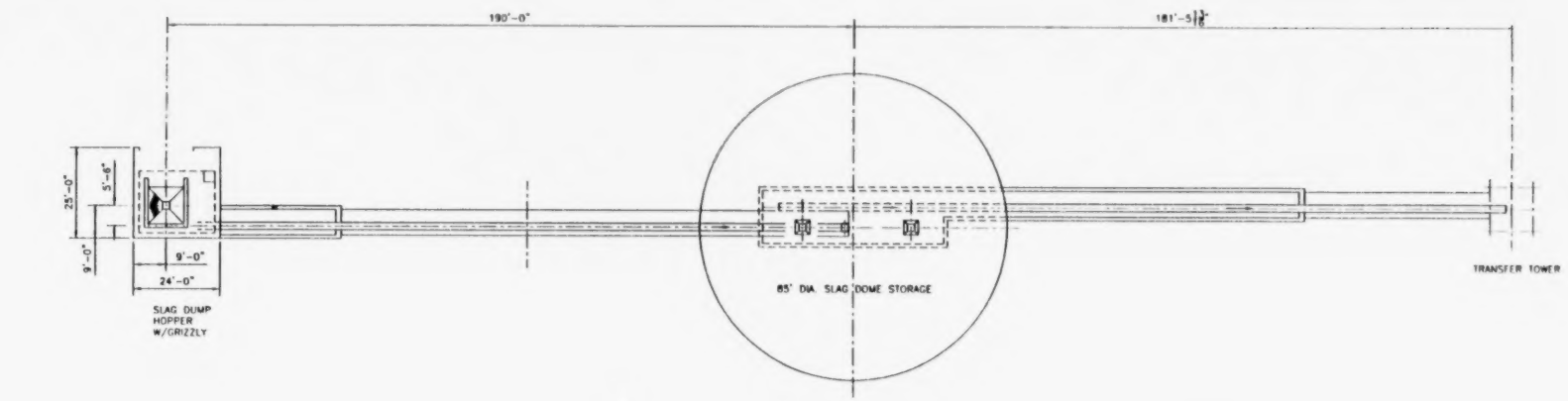

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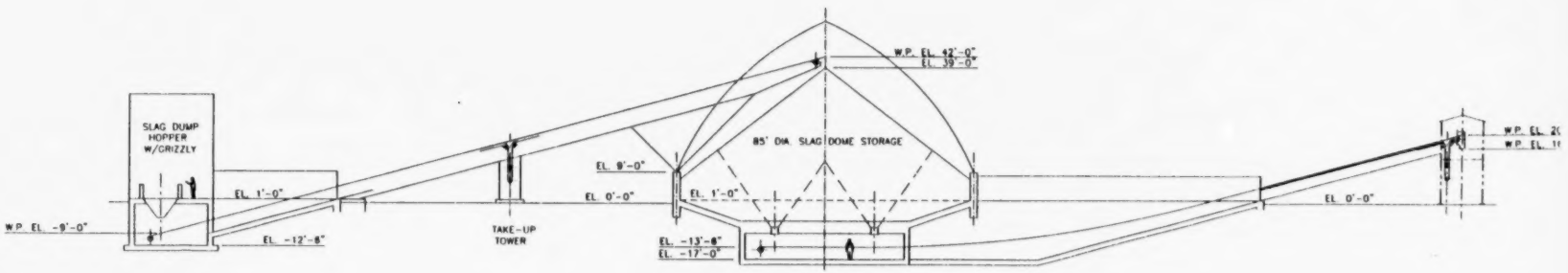

ELEVATION

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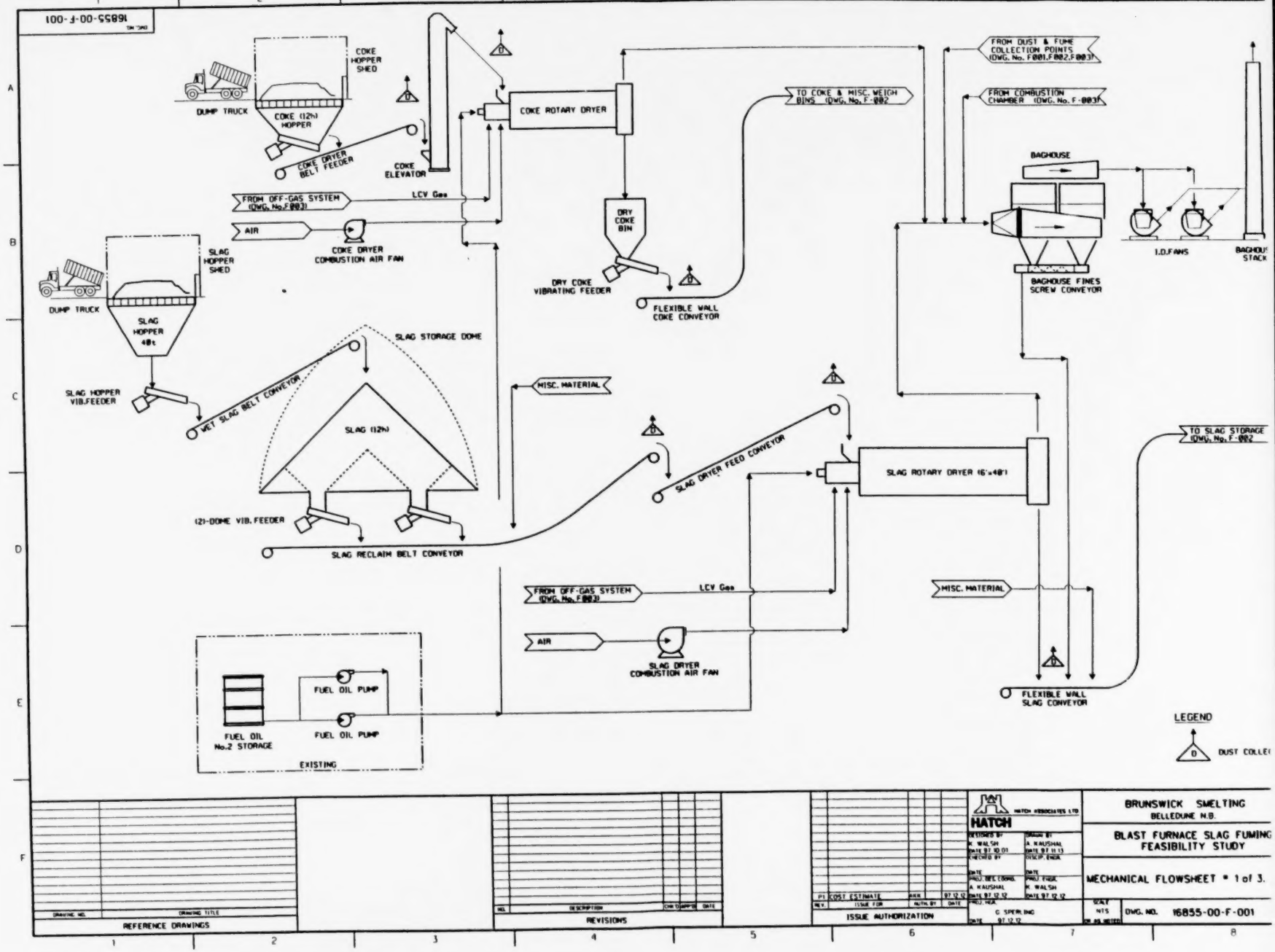
16855-00-F-001
COKE HOPPER SHED
DUMP TRUCK
COKE (12h) HOPPER
COKE DRYER BELT FEEDER
COKE ELEVATOR
COKE ROTARY DRYER
FROM DUST & FUME COLLECTION POINTS (DWG. No. F001,F002,F003)
FROM COMBUSTION CHAMBER (DWG. No. F-003)
TO COKE & MISC. WEIGH BINS (DWG. No. F-002
BAGHOUSE
I.D.FANS
BAGHOUSE STACK
FROM OFF-GAS SYSTEM (DWG. No. F003)
LCV Gas
AIR
COKE DRYER COMBUSTION AIR FAN
DRY COKE BIN
DRY COKE VIBRATING FEEDER
FLEXIBLE WALL COKE CONVEYOR
BAGHOUSE FINES SCREW CONVEYOR
SLAG HOPPER SHED
DUMP TRUCK
SLAG HOPPER 48t
SLAG HOPPER VIB.FEEDER
WET SLAG BELT CONVEYOR
SLAG STORAGE DOME
SLAG (12h)
(2)-DOME VIB. FEEDER
SLAG RECLAIM BELT CONVEYOR
MISC. MATERIAL
SLAG DRYER FEED CONVEYOR
SLAG ROTARY DRYER 16'x48'
TO SLAG STORAGE (DWG. No. F-002
FROM OFF-GAS SYSTEM (DWG. No. F003)
LCV Gas
AIR
SLAG DRYER COMBUSTION AIR FAN
MISC. MATERIAL
FLEXIBLE WALL SLAG CONVEYOR
FUEL OIL No.2 STORAGE
FUEL OIL PUMP
FUEL OIL PUMP
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D DUST COLLE
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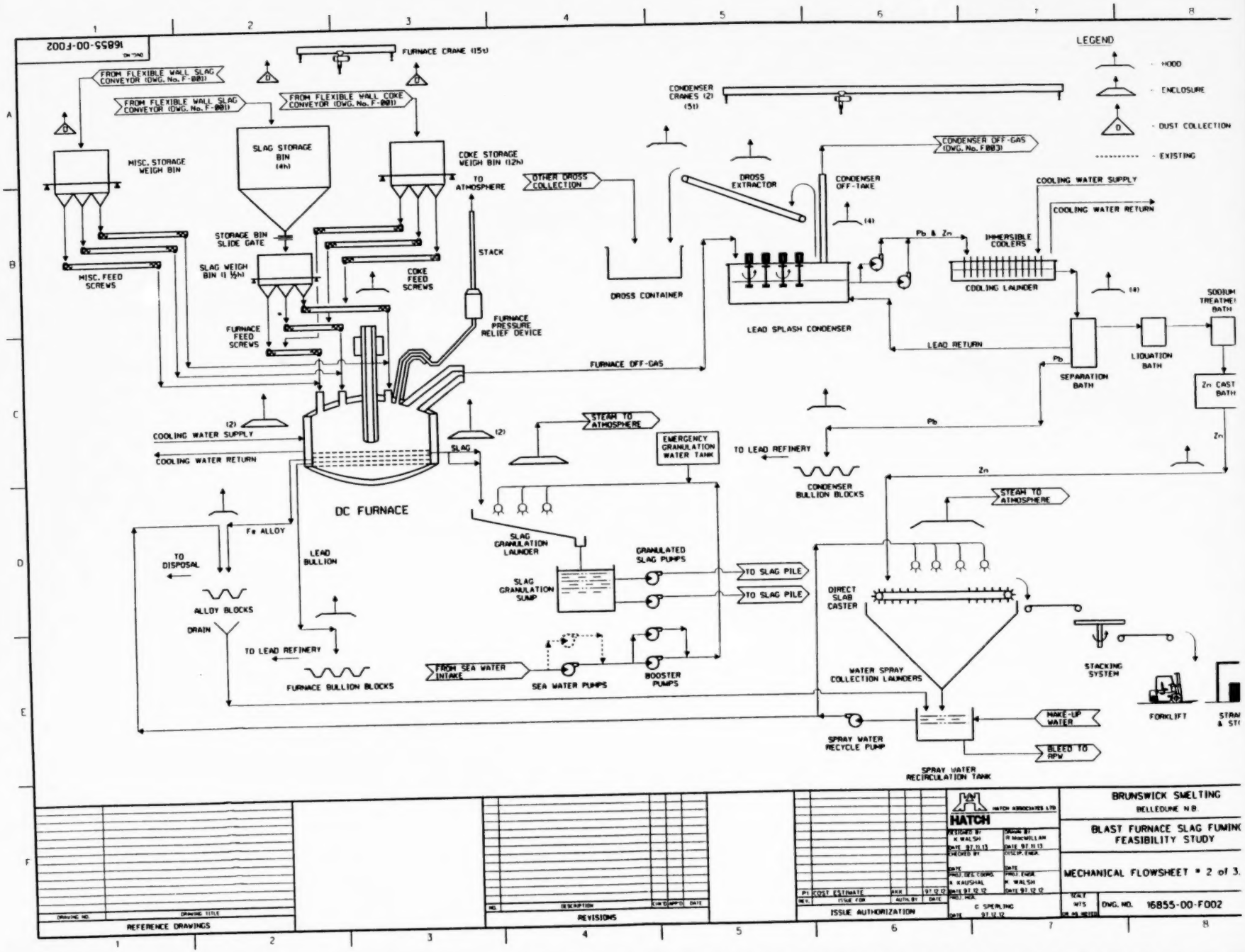
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LEGEND
HOOD
ENCLOSURE
DUST COLLECTION
EXISTING
FURNACE CRANE (15t)
FROM FLEXIBLE WALL SLAG CONVEYOR (DWG. No. F-001)
FROM FLEXIBLE WALL SLAG CONVEYOR (DWG. No. F-001)
FROM FLEXIBLE WALL COKE CONVEYOR (DWG. No. F-001)
CONDENSER CRANES (2) (5t)
CONDENSER OFF-GAS (DWG. No. F003)
MISC. STORAGE WEIGH BIN
SLAG STORAGE BIN (4h)
COKE STORAGE WEIGH BIN (12h)
TO ATMOSPHERE
OTHER DROSS COLLECTION
DROSS EXTRACTOR
CONDENSER OFF-TAKE
COOLING WATER SUPPLY
COOLING WATER RETURN
STORAGE BIN SLIDE GATE
STACK
Pb & Zn
IMMERSIBLE COOLERS
MISC. FEED SCREWS
SLAG WEIGH BIN (1 1/2h)
COKE FEED SCREWS
DROSS CONTAINER
COOLING LAUNDER
SODIUM TREATMENT BATH
FURNACE FEED SCREWS
FURNACE PRESSURE RELIEF DEVICE
LEAD SPLASH CONDENSER
LEAD RETURN
LIQUATION BATH
FURNACE OFF-GAS
Pb
SEPARATION BATH
Zn CAST BATH
(2)
COOLING WATER SUPPLY
COOLING WATER RETURN
(2)
SLAG
STEAM TO ATMOSPHERE
EMERGENCY GRANULATION WATER TANK
TO LEAD REFINERY
CONDENSER BULLION BLOCKS
Zn
DC FURNACE
Fe ALLOY
SLAG GRANULATION LAUNDER
GRANULATED SLAG PUMPS
STEAM TO ATMOSPHERE
TO DISPOSAL
LEAD BULLION
SLAG GRANULATION SUMP
TO SLAG PILE
TO SLAG PILE
DIRECT SLAB CASTER
ALLOY BLOCKS
DRAIN
TO LEAD REFINERY
FROM SEA WATER INTAKE
SEA WATER PUMPS
BOOSTER PUMPS
WATER SPRAY COLLECTION LAUNDERS
STACKING SYSTEM
FURNACE BULLION BLOCKS
FORKLIFT
MAKE-UP WATER
SPRAY WATER RECYCLE PUMP
BLEED TO RPW
SPRAY WATER RECIRCULATION TANK
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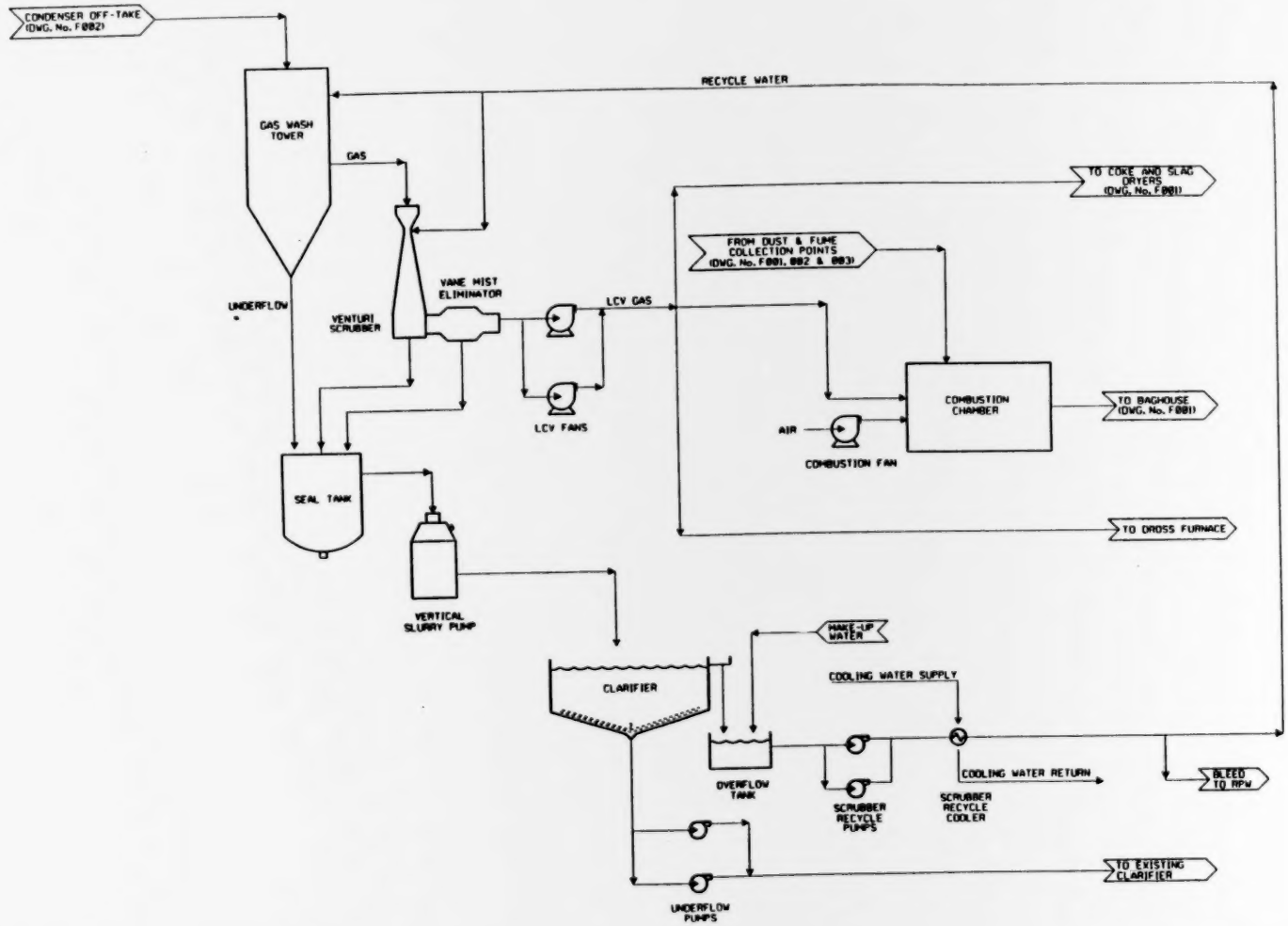

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BLAST FURNACE SLAG FUMING FEASIBILITY STUDY

MECHANICAL FLOWSHEET • 3 of 3.

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